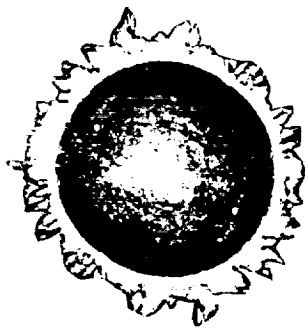
NASA-CR-194514

Ninth Annual NASA/Contractors Conference On Quality and Productivity

World Class Excellence:
The Journey Continues



(NASA-CR-194514) NINTH ANNUAL NASA/CONTRACTORS CONFERENCE ON QUALITY AND PRODUCTIVITY. WORLD CLASS EXCELLENCE: THE JOURNEY CONTINUES. CONFERENCE PRESENTATIONS (JPL) 375 p

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Conference Presentations

Jet Propulsion Laboratory
Pasadena, California
The Pasadena Center
Pasadena, California
October 20 - 21, 1992

Ninth Annual NASA/Contractors Conference on Quality and Productivity

"World Class Excellence: The Journey Continues"

Conference Presentations

Hosted by:

Jet Propulsion Laboratory
Pasadena, California
October 20-21, 1992

The views expressed herein are those of the author and not necessarily those of the National Aeronautics and Space Administration or of his/her employer.

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1.0 THE GEORGE M. LOW TROPHY--THE BUSINESS RATIONALE

Panel 1 - 1992 George M. Low Trophy Finalists - Large Business Hardware

The speakers for this panel are 1992 George M. Low Trophy finalists. The chairman represents a former George M. Low Trophy recipient organization. They will discuss the business reasons that motivated their organizations to participate in the George M. Low Trophy program.

Robert E. Lindstrom, Vice President and General Manager, Thiokol Corporation, Space Operations, **Chairman**

Louis A. Saye, Vice President, Manufacturing, Cray Research, Inc.

Carl L. Vignali, Group Vice President, Space Systems Group, Honeywell Inc.

Donald C. Morrisey, Executive Vice President and General Manager, Rocket Research Company, Olin Corporation

Introduction

Robert E. Lindstrom, Vice President and General Manager
Thiokol Corporation, Space Operations

It is a pleasure and honor to serve as chairman of this panel and to introduce both the subject and the panel members.

There is clearly a business rationale in applying for the George M. Low Trophy: NASA's Quality and Excellence Award. Thiokol believes the effort and investment required to obtain the Low Trophy was recouped many times. Our efforts were rewarded, not with just the Low Trophy, but with increased knowledge and motivation seen throughout our company..

Receiving NASA's highest honor for quality and excellence was a major milestone for Space Operations, but it's just one step in our ongoing quest for continued improvement. Our challenge now is to expand our continuous improvement/total quality management initiatives and improve future product quality. Because of our Low Trophy experience, we face this challenge with an increased appreciation for teamwork, pride in our product, and an uncompromising commitment to quality.

The 1992 George M. Low Trophy finalists with us today will also address the same question in more detail.

We will hear first from Louis A. Saye, Vice President, Manufacturing, Cray Research, Incorporated. Lou heads the manufacturing operation that produces Cray super computers at the Chippewa Falls Operation.

Next, Carl L. Vignali, Group Vice President, Space System Group, Honeywell, Incorporated will explain why he believes the Low Trophy process can make a positive impact on an organization. The Space Systems Group is an electronic components manufacturer.

Finally, Donald C. Morrisey, Executive Vice President and General Manager, Rocket Research Company, Olin Corporation will present a specialized manufacturer's view of the Low Trophy process and its benefits.

The George M. Low Trophy – The Business Rationale

CRAY RESEARCH, INC.

Lou Saye

Vice President of Manufacturing

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The George M. Low Trophy – The Business Rationale

Discipline or Dogma

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The George M. Low Trophy – The Business Rationale

Agenda

The Product

The Process

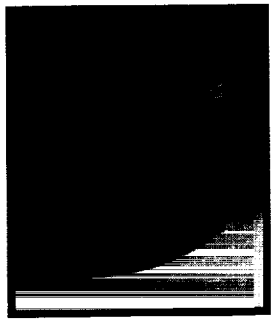
The Payoff

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The George M. Low Trophy – The Business Rationale

The Product



CRAY Y-MP EL



CRAY Y-MP C90

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The George M. Low Trophy – The Business Rationale

Applications

Aerospace
Automotive
Chemical / Pharmaceutical
Petroleum
Research Labs
University
Weather / Environment

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The George M. Low Trophy – The Business Rationale

Aerospace

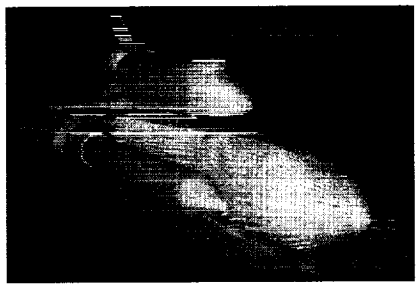


F-18 aircraft flowfield visualization.

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The George M. Low Trophy – The Business Rationale

Aerospace



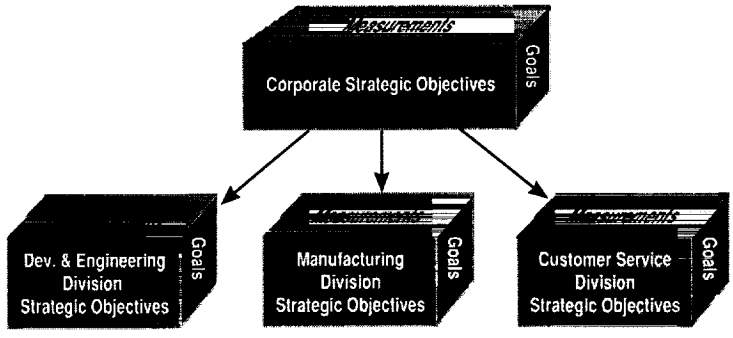
Particle tracing of airflow around ascending space shuttle.

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The George M. Low Trophy – The Business Rationale

The Process

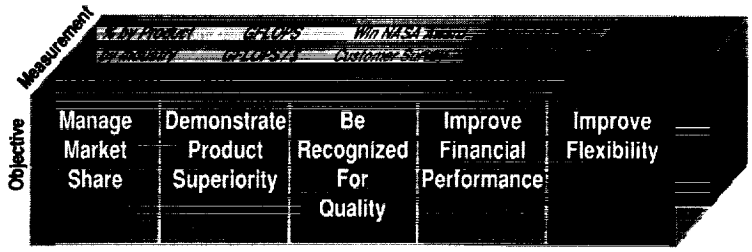


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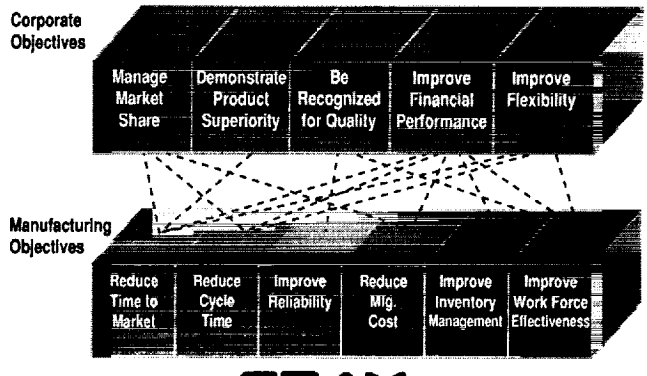
Corporate Strategic Objectives



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The George M. Low Trophy – The Business Rationale

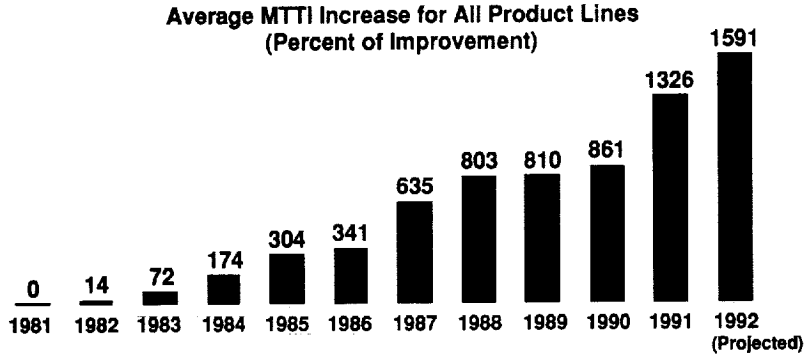
Corporate Objectives linked to Manufacturing Objectives



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The George M. Low Trophy – The Business Rationale

The Payoff – Reliability

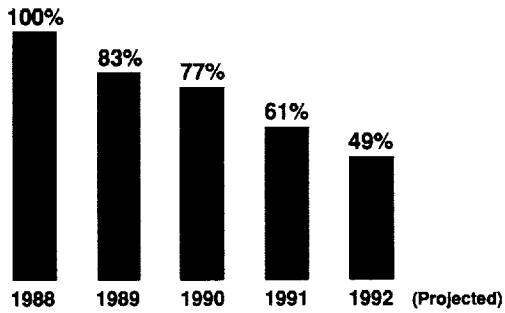


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The George M. Low Trophy – The Business Rationale

The Payoff – Cost

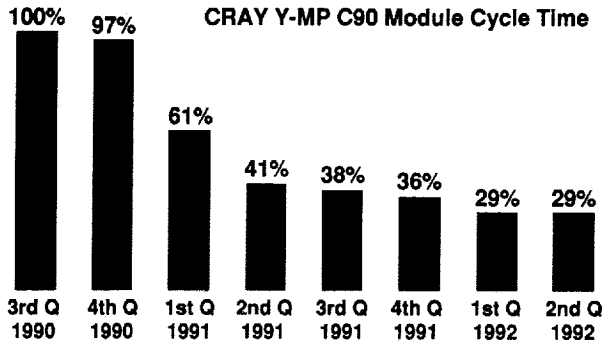


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The George [illegible] Trophy – The Business Rationale

The Payoff – Schedule



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The George [illegible] Trophy – The Business Rationale

Results

What value have we obtained from this process?

Supports Cray Research's TQIP

Valuable Internal and External Feedback

Quality System

Products and Service Quality

Cross-divisional Teamwork

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Total Quality Involvement (TQI)
at
Honeywell Space and Strategic Systems Operation
Clearwater, FL

Carl L. Vignali,
Vice President, Space Systems Group, Honeywell Inc.

Good morning!

It's a pleasure to be with you once again at the NASA/Contractors conference. I've enjoyed attending these conferences over the years. I've always learned something and it's enjoyable to network with friends and associates in the same business.

My understanding is that our focus on this panel is to discuss what motivated us to apply for the George M. Low Trophy and how that has been beneficial to us. I'm happy to do that, since I'm convinced the application process has been positive for our business and would like to illustrate with some specific examples.

The objectives of the George M. Low process are particularly applicable to our business.

Honeywell Space and Strategic Systems Operation (SASSO)

SASSO builds components and systems for a wide variety of space applications and missions. Our customer set is small and memories are long. We can't survive unless we provide customer satisfaction and quality on every program. We were established in Clearwater in 1957 and have played a role in almost every United States space program in the past 35 years.

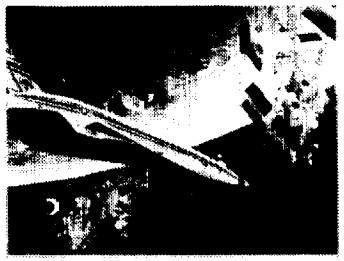
We serve four market areas: manned space, satellites, strategic systems, and launch vehicles. (See Figure 1) Our product areas include manned space (flight control, engine control, vehicle management, and GN&C systems), electronic systems (radiation hardened space computing systems), inertial systems (laser gyro IMUs), and precision inertial components (gyros and accelerometers for strategic missiles). Our programs are evenly split between development and production.

NASA programs represent about 35% of our business. We've played key roles on every NASA manned-space program – X-15, Mercury, Gemini, Apollo, Lunar Lander, MOL, Space Lab, Space Shuttle, Space Station Freedom, Assured Crew Return Vehicle, and National Aerospace Plane. In addition, we have made major contributions to NASA's unmanned launch vehicles, exploration vehicles, and satellites, including Centaur, Viking Lander, TIROS, and Application Technology Satellite. In addition to engineering support, we provided guidance, navigation, flight control, engine control, and attitude stabilization equipment to these challenging and very successful programs.

Our systems have operated successfully on every NASA program. Examples of outstanding equipment performance include our: Viking Guidance Control and Sequencing Computer, Centaur Inertial Measurement Unit (that has successfully supported over 70 Centaur launches), and Space Shuttle equipment (which has had *no* mission failures).

SASSO Market Areas

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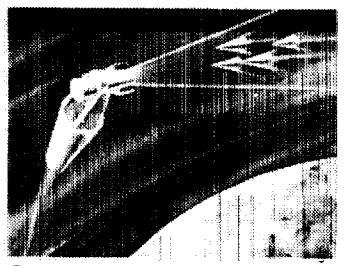
Manned Space

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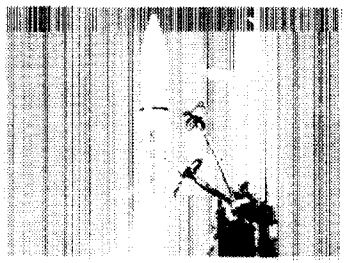
Satellites

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Strategic Systems

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Launch Vehicles

	Manned Space	Satellites	Strategic Systems	Launch Vehicles
Applications	• Space Transportation • Space Platforms	• Surveillance • Weather/Earth Sensing • Communication • Space Weapons • Science • Navigation	• Land-Based Missiles • Sea-Based Missiles • Interceptors	• Ground Boosters • Upper Stages • Orbit-Transfer Spacecraft
Key Programs	• Shuttle • Space Station • ACRV • NASP • SSTO • SEI	• FEWS • Brilliant Eyes • DMSP • MILSTAR • EOS • H490 • MSX • P-91 • TAOS	• Trident • Peacekeeper • SICBM • Minuteman • ASAT • GSTS • GBI • THAAD • ERINT • ERIS	• Titan • Atlas • Centaur • TOS • MSLS • NLS

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Figure 1

Why We've Applied for the George M. Low Trophy

Now I'd like to address the George M. Low Trophy and tell you why we've applied for the past three years.

We started a very concentrated initiative in Total Quality Involvement almost four years ago. We've plowed this ground ourselves without using outside consultants (to any degree) to steer the process. As we started this initiative, we expected some successes but realized we would have some false starts and were prepared for that. We also knew it was important to have some way to judge whether we were making progress in our overall efforts – to benchmark ourselves against others in the business world. Some of the early conclusions we reached were that 1) quality and productivity improvement is real, and it's pervasive, 2) we had to improve at least as fast as our competitors or we would lose ground, and 3) it would be helpful to have some objective measures of our progress so we could evaluate improvement.

There are several reasons why we applied for the George M. Low Trophy in the past three years. 1) NASA is one of our important final customers. If they encourage us to participate in something, which they have done with the George M. Low process, we listen. 2) Applying creates an opportunity to evaluate ourselves against criteria important to our customer. 3) The feedback from the application process has been very helpful in identifying areas for further improvement. 4) The feedback evaluations, and our relative positioning compared to other applicants, provides a credible baseline for comparing progress and discussing improvements with other companies. 5) Applying also has been motivating to our employees. The application acts as a forcing function to document our results and progress, which we have shared with employees. It gives us the opportunity to say "thanks" to them for their outstanding performance. It also gives them the opportunity - during the on-site evaluation visit - to interface directly with NASA personnel and show them what they're doing in their work areas.

While the five reasons listed above are all important, the feedback evaluations probably overshadow the others in affording opportunities for continual improvement. I'd like to spend some time discussing the feedback we received in 1991, and tell you what actions we've taken to improve our operation as a result of this feedback. This will also be a way of reviewing some specific results in the past year.

1991 Feedback Issues

1. Issue - Need a better integration of our total planning process; one that links our quality and productivity initiative to strategic planning.

 Actions and Results - We agreed this was a legitimate feedback issue. We've done strategic planning for many years, but prior to 1992 had not coupled our improvement initiative to our strategic business plan. We resolved to correct this in 1992 and we did.

 Early in 1992 we assigned an executive team to review and restructure our total planning process, integrating strategic, quality, operational, and functional group planning. This was completed in late spring in time for us to use the concept in preparing our strategic plan for 1993. Our 1993 plan, completed in July, incorporates a full-page TQI strategy and policy statement (see Figure 2), and articulates specific strategies to use TQI to improve customer satisfaction and program performance.

Space Systems Group TQM Strategy

Quality and productivity improvement is a fundamental business strategy to increase customer satisfaction and expand market share. All functional groups will participate in continual improvement activities, increasing their functional performance and SSG's operational success.

Total Quality Management (TQM) will be the overall integrated initiative within which continual improvement will be achieved. The Baldrige criteria will be the basis for quality and productivity improvement planning, and will guide the TQM initiatives. An assessment will be made each year of improvement progress against the Baldrige criteria. This assessment may be accomplished by applying for the Honeywell Quality Value and/or the Malcolm Baldrige National Quality Award.

A five-year TQI Strategy Plan, formatted to the Baldrige criteria and supported by functional group improvement plans, will be developed and implemented. The plans will be reviewed and revised each year as necessary.

Functional groups will consider their improvement plan commitments in the operational planning process, and assure there are capital and budget monies available to accomplish objectives. Near term (one-year) improvement objectives will be included in the G&O planning process for the coming year.

Figure 2

Our new planning process also requires a five-year TQI Strategy Plan which will detail goals and actions to be completed by functional areas. The functional groups will prepare 1993 plans which incorporate the TQI strategy and respond to actions detailed in the TQI Strategy Plan. Figure 3 details this total planning process.

We're convinced this integrated planning process will bring more focus to our improvement initiative and makes us a more effective team. Putting this plan together has spawned many discussions among my staff of the strategic importance of TQI and how we can better use it to enhance customer satisfaction and improve the business.

2. Issue - Internal communications could be improved. There is more tops down than bottoms up communication.

 Actions and Results - We performed an all-employee communications survey early this year to assess how we could improve our upward communication. Employee response was candid and sobering. They were hard on us. We clearly had some work to do in this area. We compiled, analyzed and distributed the data to managers with recommendations – some of which are directly from employees – of how to improve communications. It was clear employees wanted to know more about where the business was headed and wanted more opportunities to communicate their ideas. Each major department head now has a communications plan for his/her group, and regularly communicates business information in staff meetings, department meetings, and program or department newsletters. Dr. Bill Poe, V.P. of SASSO, has begun a series of monthly open forums which can be attended by all employees to present their ideas, ask questions and get answers. We've also asked each executive to have monthly sensing sessions with employees.

3. Issue - Energy conservation plan is not well focused. Need a focal point to coordinate.

 Actions and Results - This was relatively easy to resolve. We already had this activity concentrated in one department, but did not have one person coordinating it. We've appointed one person to lead the activity, and he coordinates energy conservation activities with all other departments. A multi-functional TQI improvement team has been formed to identify energy conservation ideas (about 25 so far) and implementation plans.

4. Issue - Some work standards seem out of date. They need to be reviewed and updated.

 Actions and Results - This was a valid criticism and we had already concluded that action was needed. The feedback confirmed it. Work standards were reviewed in all plants, and we implemented a project in 1992 to upgrade those that were getting out of date. This has enhanced our ability to more accurately price our products in these areas.

5. Issue - Need to form better partnerships with suppliers and involve them in business strategy.

 Actions and Results - We have involved key suppliers, particularly other Honeywell divisions (Solid State Electronics Center & Inertial Instrument Operation), in formulating and implementing our strategies. We are working much closer with GCI, our local PWB supplier, via concurrent engineering on critical programs. We share our business forecasts with them. We began implementing a supplier certification program in early 1992 and expect to have 10-12 certified suppliers by the end of the year. Our overall material strategy, which we have passed along to our suppliers, is to a) have a few good suppliers, b) assure supplier processes are certified and under control to produce quality parts that we don't have to

SASSO Integrated Strategic Planning Process

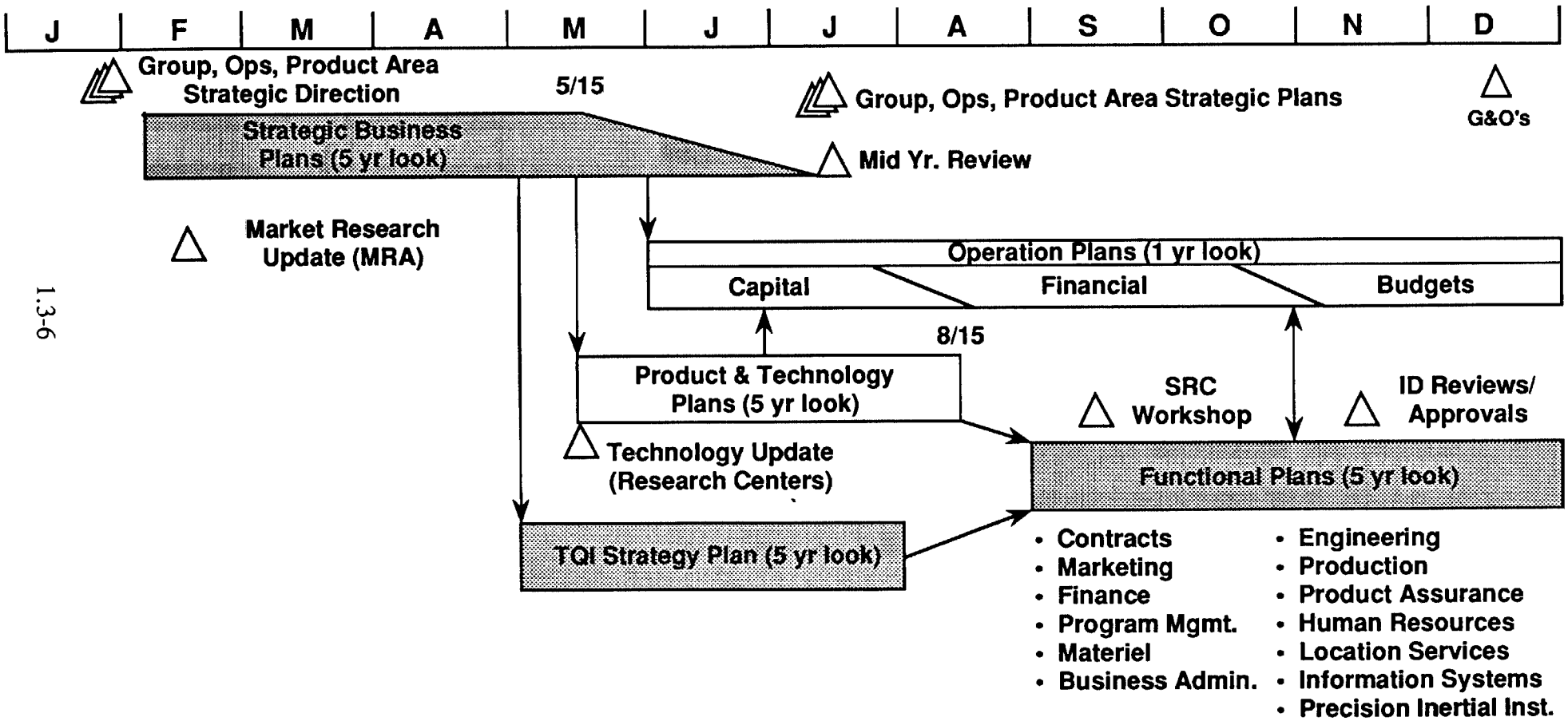


Figure 3

inspect, and c) to form long term relationships that are mutually beneficial to both parties. This overall strategy has reduced our suppliers from 700 to 250 over the past five years. (These numbers represent suppliers who ship us three or more lots/year.)

We have made significant improvements in our business processes as a result of the feedback we received from our GML application. The feedback is credible to our people, they believe it and are willing to act on it. It has definitely helped us focus and prioritize the issues and to speed up improvements to our business.

Feedback Recommendations

Now, on this subject of evaluation feedback, I have some recommendations for NASA which we feel would make the feedback even more helpful.

a) First, we appreciate getting the feedback sooner in 1992 (August) than we did in 1991 (December). Obviously, the sooner we get it, the sooner we can start to improve the things you think are important.

b) Feedback should be in all eighteen categories, not just a few. Strengths, weaknesses and recommendations for improvement should be identified for each category.

c) Give the feedback in written form as well as verbal. Sometimes things are overlooked or misinterpreted if only communicated verbally.

d) Tell us how we scored in each category. This is one of the few ways we can tell if we're improving, by comparing our score with previous years.

Other TQI Results

The issues discussed above do not include all of our improvement activity. I'd like to highlight some additional results from initiatives carried into 1992.

1. We are thankful to be a NASA George M. Low finalist for the past three years. It has been an effective yardstick in calibrating our improvement progress.

2. Within Honeywell, we were one of two recipients of the Honeywell Quality Value (HQV) in late 1991. The HQV is a corporate improvement initiative and is structured identically to the Malcolm Baldrige National Quality Award process. The major benefit in applying for the HQV was once again for the feedback received. The HQV applications are reviewed and graded by Baldrige examiners, and the feedback was very detailed. The HQV feedback paralleled some of the NASA feedback which reinforced the priority we gave these issues. We've just submitted our HQV application for 1992 and expect to get feedback by late November.

3. Employee participation in TQI continues to increase. TQI is now a common phrase in our business vocabulary and it is the rare employee who is not involved in an improvement initiative or project. There are three good ways to illustrate this: 1) participation in our suggestion program, 2) number of TQI improvement teams, and 3) number of comments via employee feedback.

 We restructured our suggestion program – which we call Great Ideas – three years ago. Results over the last four years show some impressive trends. Ideas/employee have

increased 600%, savings have increased 383%, and turnaround time to close out suggestions has decreased 49%.

We now have 300+ TQI improvement teams with about 1200 employees participating. These teams are throughout the entire organization and represent all functional groups. The following highlights some of the team accomplishments:

- SSMEC Acceptance Data Package - process time reduced 63%, page count reduced 94%. This was a joint Honeywell, Rocketdyne, DCMC team.
- SSMEC Inspection Point Reduction - 469 inspection points (29%) reduced in controller subassemblies. Again, this was a joint Honeywell, Rocketdyne, DCMC team.
- Finance - reduced the time to close the monthly books from eight days to four days.
- Security - number of security violations has reduced 72% since 1986.
- Engineering - formed cross-functional team to reduce PWA cycle time by 50%.
- Quality - customer audit scores increased from 76% in 1990 to 96% in 1991.
- SASSO financial performance - since 1987, revenue is up 28%, profits 50%, and revenue/employee 54%. TQI is definitely improving operational financial performance.

Summary

I've tried to give you some insight on why the George M. Low Trophy process has been important to us at SASSO, how it's helped us improve our operation, and some things we've accomplished as a result of applying. We could debate for a long time about what criteria is best to follow and the pros and cons of applying for an award such as the George M. Low. If you're a NASA supplier and have not applied, I encourage you to do so. You're almost guaranteed to learn a lot about your business, and how you operate, in the process. The feedback you get will confirm some things you may already suspect and will reinforce actions considered important by one of your most valuable customers. It's worth the effort. As we continually improve, there's nothing more important or valuable than listening to our customers.

How Are We Doing?

Donald C. Morrisey, Executive Vice President & General Manager
Rocket Research Company

Rocket Research Company is a 30 year old company, with 500 personnel doing about 70 million dollars in annual sales. Located in Redmond, Washington, just east of Seattle, this company makes most of the small guidance rockets launched into space. The business is about 50/50 Commercial and Government work, and many of NASA's key programs have been supported by the Rocket Team including Voyager (the "Grand Tour"), Viking mission to Mars, Magellan mission to Venus, Mars orbiter, Space Shuttle and Space Station. Other (non-NASA) programs include NAVSTAR (GPS), several DOD satellites, many commercial satellites, and most of the major launch vehicles in the U.S. including Delta, Atlas, and Titan, and encompassing upper stages such as PAM and Centaur.

In the "old days", the company achieved its record of high quality through a very rigorous, structured system of controls, inspections, and constant verification. This resulted in a bureaucratic, ordered and conservative management. No one questioned the boss. You did what you were told to do.

Five and a half years ago, I became the General Manager. It was time for a change in thinking at the company. The world was passing us by; for example, we had over 150 engineers and four personal computers. Hand calculators were the standard. You wanted a computer, you bought it on your own. People didn't complain, they grumbled.

I attended the Fifth Annual NASA Contractors Conference on Quality and Productivity in October of 1988, that's THIS meeting four meetings ago. It was just what I needed. Other companies were succeeding at what we were trying to do. They had organized approaches, methods, ideas and advice. . . and they made it look easy!

Terrific! If Rocket Research Company could design and deliver rocket engine modules on a S.D.I.O. program in 12 weeks - which we had done earlier that year - we should be able to have T.Q.M. up and running smoothly in a couple of months. So I returned to Washington State full of enthusiasm, and had a meeting of all company management from Supervisors to Vice Presidents.

"We", I said, "are going to do T.Q.M. So get busy and do it, and thanks a lot for the enthusiasm I know you'll have!" I explained everything to them: employee empowerment, coaching, listening to customers, meeting expectations.

Today, most of the managers don't recall that such a meeting ever took place. They were in such shock, their minds have blocked out the event to preserve their sanity. So all the average worker ever heard about this was that management had some new thing they were pushing and that it would probably be wise to keep low for awhile until it passed.

At the NASA symposium we had learned that the top management has to make it clear to everyone in the company that they are commited to the T.Q.M. process. Somehow I had to convince the entire company that the culture change was underway. My opportunity would have to be the annual get-together of the entire company on the last working day before the Christmas holiday. I was to provide the traditional report of company accomplishments for the year. I resolved to make it obvious to all that the management style at Rocket Research was changing from authoritative to participative.

My speech went something like this: "I am your leader. People ask me what that means. I reply that I am here to guide and help light your way so that you can do your work tasks more effectively. You are the one who accomplishes; I only guide. Henceforth, I do not give orders, I guide. I am out front . . . leading."

I then put on my antlers and red nose, and proceeded to give the rest of my talk as "Rudolph, the Red Nosed Reindeer". I will never forget the reaction, as individuals in the meeting started to get it. First silence, then murmurs, then snickers, and finally some applause. No manager in the history of the company had ever made a complete fool of himself before, and so the point had been made: There was a new leadership. T.Q.M. had been launched! Anyone could now approach the top management. I wasn't royalty. I wasn't <u>better</u> than anyone. I was obviously some kind of nut who <u>needed</u> their help.

This meeting was followed by many other meetings and events to continuously demonstrate management commitment. The company-wide training in T.Q.M. went on for a year, the T.Q.M. structure was created, improvement projects implemented, surveys conducted and many of the techniques reported by other companies were employed. We celebrated our successes, and we really felt we were a better company. The whole atmosphere seemed to change.

But, how good were we . . . really? We didn't know. No one would give us a straight answer. If we asked our customers, they said we were OK. If we asked our personnel, they said things were better. Our suppliers, of course, said they loved doing business with us. Our community said we were good neighbors. Our corporation said our profits were up and we hadn't done anything to embarrass them, so they were happy with us. As a consequence of everyone trying to be polite, we didn't have any real idea how good we really were.

We decided to submit an application for the 1990 NASA Excellence Award. We were not selected as a finalist, so we didn't receive a site visit, but NASA and ASQC reviewers provided a marvelous critique of our application. I and two others attended the debriefing they held for us at NASA Headquarters in Washington, D.C. and we all took notes as fast as we could write, during the meeting. We issued a joint nine page memorandum which management used as a check list for focusing our improvement activities. NASA nailed us on the weaknesses we knew we had, but they also revealed things we hadn't realized and provided objective advice that we found invaluable.

At last, we had an unbiased assessment by truly qualified experts as to our status. They talked with our customers, and our customers leveled with them. We found this debriefing to be the most objective source of data we could have hoped for.

We had much to do and we did it, as fast as we could, but the following year we knew we had not progressed as far as we needed. Additionally, we were really too busy to prepare an application.

By the way, there's a lesson in this that we now realize. If you're too busy to submit an application for the George M. Low Trophy, you shouldn't bother because you're not ready. The biggest effort we had encountered in preparing our application was the gathering, compiling and analyzing data needed to document continuous improvement trends. But now it's obvious to us that if the data, called T.Q.M. metrics, isn't actively being maintained and utilized to measure improvement, then the improvement isn't being managed . . . and if it isn't being well managed the ASQC will not select you as a finalist. If you DO measure improvement continuously, and thus manage it, then the metrics needed for the application are already available . . . and preparation of the application is relatively straight forward.

This is what we found to be the case for our application last year. It was relatively straight forward. But we had been asleep at the switch on some items, and this was discovered during the preparation process. So we learned during the preparation process. Then, by being a finalist, 20 NASA people visited our plant site to do a detailed 2-day review and verification of our application. Before they left, we received an informal debriefing which was helpful in that they told us their impressions of us while it was still fresh. So we learned during the site visit. Two months later, they gave us a detailed assessment of our T.Q.M. status based on the ASQC review of our application and the NASA site visit and review. The data we have received is priceless and thus we learned during the debriefing; more on that later.

The site visit was a rewarding experience for us. We had a brief opportunity to present an overview of our company. Then the NASA people spent the balance of the time reviewing our backup data and talking with our people. The backup data is essential to assure that the evaluation is fair. A company could say in its application that it issues a weekly company newsletter in seventeen languages, and the ASQC will accept that as fact . . . although it's likely they will want to see some examples when they arrive. There isn't enough space in the application's 35 page limit to include backup for everything, and proper verification is essential to fairness.

But the Best Part of the site visit, and a primary benefit of being a finalist, is the one-on-one exchanges between the visitors and your personnel. These NASA people are good! They are knowledgeable, enthusiastic, and personable. Every one of our personnel who was "interviewed" felt it to be a rewarding experience. Our company morale has been greatly enhanced by the visit. Frankly, it was a lot of fun.

We had an ice cream social during lunch hour the first day. Our personnel were so enthusiastic about having the NASA visitors at our plant that they mobbed them. It was

a powerful motivation for our team. Our people are proud of what they do. They were delighted that the NASA people wanted to listen to them talk about their work.

Everyone at Rocket Research is anxious to know "How am I doing; how are We doing?" And this was a unique opportunity to ask the question and get a straight answer. Thereafter Rocket Research received the two debriefings and learned more about how we are doing. We have been fully rewarded for all of our efforts by these debriefings. Now, we can concentrate our efforts on our biggest weaknesses. We now also have a wide spectrum of critique from experts so that we have a better appreciation of the ways in which we can invest our resources to gain the most benefit on our path of continuous improvement.

2.0 THE GEORGE M. LOW TROPHY--THE BUSINESS RATIONALE

Panel 2 - 1992 George M. Low Trophy Finalists - Large Business Software and Service Support

The speakers for this panel are 1992 George M. Low Trophy finalists. The chairman represents a former George M. Low Trophy recipient organization. They will discuss the business reasons that motivated their organizations to participate in the George M. Low Trophy program.

Jarvis L. (Skip) Olson, Program Vice President, Shuttle Processing Contract, Grumman Technical Services Division, **Chairman**

John B. (Jack) Munson, Corporate Vice President, Space Systems Operation, Paramax Corporation

Anthony J. Macina, Vice President and General Manager, IBM Federal Systems Company - Houston

George R. Faenza, Vice President and General Manager, Kennedy Space Center Division, McDonnell Douglas Space Systems Company

Introduction

Jarvis L. (Skip) Olson, Program Vice President, Shuttle Processing Contract, Grumman Technical Services, Chairman

It is a unique honor for me to be here this morning to say a few words about the George M. Low Trophy process, and to introduce our panel members.

The George M. Low Trophy, NASA's Quality and Excellence Award, was the nation's first quality award. It was created to recognize aerospace companies that have demonstrated a continuing commitment to quality in all aspects of their performance. The trophy is named after, and honors a man who represented quality and excellence in all that he did. He implemented the principles of total quality management long before TQM became the benchmark for American management.

The award process is structured to provide an objective measure of performance against specific criteria, to give very clearly-defined feedback to each applicant pointing out improvement opportunities, and to provide guidelines for continuous improvement.

Grumman participated in this process for three years before becoming a recipient in 1991, so I know firsthand how well the process works. Feedback from the evaluation team and participation in seminars like this were a substantial benefit. We learned new techniques and fine tuned others. While self assessment of our progress was a good idea, hearing it from our customer proved invaluable in our never-ending Journey to Excellence.

Does it make good business sense to pursue this award? With us today are three finalists who answered that question. They will discuss the business rationale behind embarking on their Journey to Excellence.

George R. Faenza is Vice President and General Manager of the McDonnell Douglas Space Systems Company at Kennedy Space Center. His company performs or supports all phases of processing for space shuttle horizontal and vertical payloads from the time a payload is scheduled to fly, through launch, landing and payload deintegration after a completed mission. McDonnell Douglas supports processing of selected payloads that fly expendable launch vehicles and they are providing design and construction surveillance of the Space Station Processing Facility.

Anthony J. (Tony) Macina is Vice President and General Manager of IBM Federal Systems Company in Houston, Texas. IBM was a co-recipient of the first NASA Excellence Award in 1987. His company provides information management systems for NASA and other primes. They design, develop, integrate and support hardware and software for the:

- Space Shuttle Avionics Systems
- Program Compliance and Status Assurance System
- Mission Support Contract
- Space Station Data Management Systems and,
- Mission Support Directorate Operations Support Contract (MOSC)

John B. (Jack) Munson is Systems Corporate Vice President of Paramax Space Systems Operations in Houston, Texas. Jack's company is a finalist for the third time. As a subcontractor to several NASA prime contractors, Paramax supplies software products, services, and support for several major programs at the Johnson Space Center , including:

- Space Station Control Center development
- Mission Control Center upgrades, and
- Space Shuttle and Space Station software product and quality assurance.

George M. Low Trophy Application - The Business Rationale

John. B. Munson
Vice President
Paramax Space Systems

Paramax Space Systems has gained some exceptionally valuable business management tools by implementing Total Quality Management and applying for national quality awards like the George M. Low Trophy. I'm going to briefly describe some of our experiences with TQM and the awards process, and afterwards I'll be glad to answer any questions you have.

First of all, the awards process represents a crucial portion of Total Quality: honest and sometimes painful internal and external assessment of an organization's health and productivity. For those of you who have not undertaken such an evaluation, let me tell you the decision to do so is an act of bravery. You must be willing not only to admit there probably are weaknesses in your organization, but you must also be prepared to develop and implement appropriate changes.

We conduct self-evaluations routinely throughout Space Systems. Every organizational component, from working groups through the program-level, measures its performance weekly against key quality and productivity factors determined by the components themselves. The results are publicly posted on bulletin boards and are frequently reviewed by our customers, with whom we are co-located.

We conduct comprehensive, organization-wide self-evaluations several times each year. These are done during our annual budgeting and strategic planning sessions, and when we apply for national quality honors like the George M. Low Trophy. The award competitions also lead to external evaluations by quality program experts who give us objective appraisals of our strengths and weaknesses.

Our applications are, in fact, the keystones of our national benchmarking process. The knowledge we gain while preparing them - and in subsequent evaluations, debriefs and conferences - helps us compare ourselves with other aerospace and software companies.

In addition, seminars like this provide an important forum for TQM networking. The contacts we make in these meetings, and others like it, have led to numerous information exchanges with delegations from other companies that we have hosted at our facility. We also have sent teams of our own TQM leaders and trainers to make presentations at other organizations, including universities in the South and Southwest.

Team-building is one of the greatest benefits of TQM and the award application process. The exceptional teamwork our employees displayed while planning and hosting our site visit by George M. Low Trophy examiners exceeded our most optimistic expectations. The award process has been extremely valuable in motivating employees and maintaining high morale.

Our entire work force takes a great deal of pride in the external recognitions we have received. This is the third consecutive year we have been selected as a Low Trophy finalist. We have received the Johnson Space Center Team Excellence Award - JSC's top honor to businesses - two years in a row. Dozens of our employees have received the space center's Manned Flight Awareness Award or the Silver Snoopy, the astronaut corps' personal honor for significant contributions to flight safety and mission success. In addition, two of our managers have received the space center's highest TQM honor to individuals, the Quality Partnership Award. One of those winners is now program manager of our software Safety, Reliability, Maintainability and Quality Assurance work for the Space Shuttle and Space Station programs.

These commendations eloquently underscore our customer's confidence in our performance. The recognitions have earned us the respect of our business community and caused us to be selected as a partner or teammate on five additional contracts in the last three years. Our software responsibilities have been expanded to include Space Station operations and both the Lunar return and manned Mars missions of the Space Exploration Initiative. Also, through contract options exercised years in advance, our Shuttle software work has been extended until 2001.

Our applications for the George M. Low Trophy and other national quality honors provide concise organizational status summaries that we have adapted into an annual business report. All employees are encouraged to read it, and copies are distributed to our customers and to other corporate components. Gathering, analyzing and organizing information for award applications also significantly aids our strategic planning process. Our business discriminators become readily apparent, as do the areas that need improvement.

In the same way, the applications furnish a "roadmap" to help us continuously improve our processes. The reports make it easy to identify procedural changes, corrections and other modifications that have worked effectively, and those which have not. The applications also help employees understand that assessments are an important way to increase our overall effectiveness and strength, and in no way represent a threat.

The feedback given by application examiners is perhaps the key element in the entire award process. Their objective assessments can locate strengths and weaknesses which we may not be able to see ourselves. Major improvements have resulted from comments made during the debriefings.

However there are some pitfalls that must be carefully avoided. As the examiners themselves point out, they evaluate organizations against generic criteria. Their suggestions may not necessarily be appropriate to a specific organization's needs, or could even be detrimental if adopted. Applicants must carefully study and weigh the recommendations to make sure implementation will improve the organization as a whole.

Applicants similarly must gauge each year whether their continued participation in the awards process will produce additional benefits for their organization. If it has mature and effective TQM, the effort and costs of applying for awards may produce marginal or diminishing returns.

There is an additional danger that is even more serious. Changes made solely to improve an award score could easily degrade an organization's performance, especially if employees believed the company participated in the application process merely to win an honor. The work force would quickly become cynical and demoralized, and performance would plummet.

On balance, however, our participation in the George M. Low Trophy application process the past three years has been analogous to the manned space program: the considerable benefits have more than outweighed the attendant risks.

BENEFITS OF APPLYING FOR THE GEORGE M. LOW TROPHY

by

A. J. Macina
Vice President and General Manager
IBM Federal Systems Company
Houston, Texas

Over the past several years, I've spoken to many audiences on the subject of IBM quality. I'm paticularly honored to speak to this audience on the benefits of applying for the George M. Low Trophy, because it is something I believe in and can recommend to every NASA contractor.

My collegues and I experienced those benefits first hand. We won the NASA Excellence Award for Quality and Productivity--the predecessor of the George M. Low Trophy--in 1987, the first year the award was given. Martin Marietta was a co-recipient. It was the first major quality award we applied for. It gave us an insight, a discipline and a framework to improve our quality even more.

I will say more about that, but first I would like to tell you a little bit about who we are.

My site is one of five major sites in the IBM Federal Systems Company, formerly the Federal Systems Division. We became a separate company in IBM earlier this year. Our name changed, but our mission did not. Our job is to provide large, complex information processing systems to agencies of the federal government. We are and always have been a full-service systems integrator. We sell hardware and software products and offer a complete range of systems engineering and systems integration services.

IBM's history with NASA goes back to the 1950s, when we provided ground control computers for the Vanguard Program. Since then, we have developed man-rated information systems on the ground and onboard the spacecraft for every U.S. manned space flight program.

In 1962 IBM moved to Houston to help NASA develop the central data processing system for Mission Control at the Johnson Space Center. We provided the Instrument Unit on board the Apollo/Saturn rocket and onboard computers for Skylab, Apollo/Soyuz and Space Lab.

In 1973 we won a contract to provide the onboard data processing system for the Space Shuttle, a contract we still hold today. Four years ago, we won a contract to develop the Space Station's onboard data management system. About the same time, we began developing information systems to help NASA manage the Space Shuttle and Space Station programs.

Today we are involved in a wide variety of space projects. In addition to the projects I already mentioned, we also have contracts to upgrade software in the current Mission Control systems, design new Mission Control facilities for the Space Station era, develop new training and simuation systems for the Space Shuttle and Space Station programs, and support the Johnson Space Center's insitutional computer systems.

Our business has always been to provide high performance computing systems for advanced scientific applications for NASA's operating centers. But recently we began expanding to NASA research centers and Department of Energy research labs. Today we are involved with projects at several NASA and DOE labs to develop high performance storage and file systems, highly parallel supercomuputing networks, and RISC workstation clusters.

We have six "product lines", so to speak: space avionics systems, ground command and control systems, training and simulation systems, high performance computing systems, management and information systems, and services and consulting. To create them, we use our skills in system engineering and program management to combine the latest technology in custom-made and commercially available hardware and software. The result is a completely integrated, turn-key solution.

We have about 1,100 employees in eight locations. About 75 percent are college-educated software programmers, systems engineers and systems analysts. Our employees did not have to be "convinced" of the importance of quality. IBM has always had a "quality culture". IBM's quality principles--we call them our Basic Beliefs--were laid down nearly three decades ago. They are, simply, respect for the individual, excellence in all things, and service to the customer.

Like any living thing, our quality principles have evolved and expanded over the years in response to changing business conditions.

When we won the contract to develop the Shuttle's onboard avionics system in 1973, NASA's requirement was that the software be error-free. At first, we produced software that contained 2-3 errors per thousand lines of code. We quickly realized that traditional software development methods would not produce the quality that NASA demanded. We realized that you can't manage quality into a product; you have to build it in. Flow charts don't produce results; people do.

So in 1979, we established a set of software quality principles that served as the basis of assumptions for re-thinking and re-making the way we developed software. The principles reflected an attitude or mind-set that already had been formed by our Basic Beliefs.

First, we said that quality is defined by the customer in written requirements or unwritten expectations. Second, we said that no defect is acceptable; our goal is zero errors, no less.

Lastly, we said that the process must be well defined and well understood by everybody. Not just management or a few experts, but everybody who touches it.

The last principle was and is, without doubt, the most important. When we started to apply these new principles, results began improving immediately. A few years ago, the corporation began a company-wide drive to improve the quality of all IBM products. We call it Market-Driven Quality, but the principles are the same as TQM.

IBM's Market-Driven Quality initiatives are much the same as the principles our site has been using to improve our software. The first item on both our agendas is empowering employees.

In the corporation and in Houston, management turned over control of the software development process to employees. We gave them the power to change and improve their processes as they saw fit. We gave them tools and methods to measure their progress, set high goals for both quality and productivity, and then got out of the way.

The results have been remarkable. Quality has improved steadily. For example, since 1983, our product error rate, which already was considerably better than industry, declined from about 2 errors per thousand line of code to almost no errors. The past two systems we delivered to NASA contained no errors at all.

The quality of our product improved because the quality of our process improved. The percent of errors we detected early in the process, before independent testing began, rose from 50 to 80 percent.

But software error rates aren't the only measure of success. The quality of all our products ranges from 4.4 Sigma to Six Sigma. Our award fee scores, which measure customer satisfaction, average more than 95 percent. Our morale is one of the highest in the corporation. Ninety-four percent of our employees say they understand IBM's Market-Driven Quality principles. Ninety-one percent say they believe that IBM lives up to its Basic Beliefs.

These results have made it possible for us to win several awards and other forms of recognition over the years. Winning the first NASA Excellence Award in 1987 gave us the the discipline and confidence to submit our process to other evaluations. In 1989 a team of NASA experts evaluated our Shuttle software development processes against the criteria of the Carnegie Mellon Software Engineering Institute and rated it a "5", the highet score possible. We received IBM's Market-Driven Quality Award twice. How do we produce results like these? The key is getting every employee to buy into the need to improve quality. A big part of that is attitude. We are truly obsessed with quality. That feeling pervades every level of our organization from top to bottom. Or, I should say, from bottom to top. Everybody has a role to play.

Our top management devotes 100 percent of its time to quality. The message we send out to employees is that we are serious about quality; we expect nothing less than perfection. We set high goals for the site as a whole, but we refrain from imposing arbitrary measurements from above on particular parts of the business. Instead, we delegate ownership of key processes to middle management and hold them responsible for the results.

Middle management, in turn, divides the processes into subprocesses, hands over control to employees, and holds them accountable for results.

The work flow is controlled by teams made up of the managers who own the processes and the employees who use the processes. More than 78 percent of our employees participate in one or more teams.

Each team is responsible for knowing who its customers are, analyzing and documenting every step of its process, choosing and collecting its own measurements, and carrying out a plan to improve its process based on what the measurements say.

Quality goals are part of every employee's performance plan. Pay and promotion are determined, in part, on whether the employee achieved his or her quality goals and how well he or she worked with the team. This applies to vice presidents as well as programmers. This is one of the ways we build continuous improvement into the system.

The secret to developing good software is, I believe, attitude. It's having a good process but never believing it's right. Our philosophy is, "There's no such thing as error-free software. There are only errors that haven't been found yet." We use a two-step, pro-active and re-active approach to continually improve our processes.

Whether or not we find a defect or have a problem, we constantly and systematically analyze our processes. One way is to take advantage of external evaluations, like the George M. Low trophy, to identify weaknesses and correct them. We are constantly trying out new technology (like automation, better management techniques and new software tools) to squeeze out better results. Recently we started doing our own advanced research on advanced complexity analysis and reliability modeling. We're working with the AIAA, IEEE and the University of West Florida to find new ways predicting software reliability and identifying the parts of the code most susceptible to failure.

When we find an error, we assume that the problem is with the process, not with the people. We don't blame, because we believe people can't learn from their mistakes in a blame-filled environment. Instead, we treat errors as opportunities for improvement, not mistakes to be shifted or covered up. No matter what kind of defect it is, we use the same method to make sure it doesn't happen again.

Our systematic, closed-loop defect prevention process is one of the best tools we have for continuously improving our processes. It's a simple, four-step process that we apply to every error we find. First, we find and fix the error. Second, we find and eliminate the root cause of the error. Third, we fix the fault in the process that let the error escape undetected. Fourth, we seek out and eliminate similar errors and faults in the process.

The team that owns the process that produced the error conducts the investigation. They report their findings to management and the customer and take the necessary corrective actions. Our defect prevention process is so effective that IBM uses it throughout the corporation.

Naturally we're proud of our processes. But I must be honest and tell you that results like these did not happen overnight. It took many years of trial and error to get where we are today.

Where do we go from here? The only thing we know for sure is that we can't let up. Our customer is demanding more from us. Our competition is getting better every year. We have to keep improving.

Today our challenge is to transfer what we've learned about developing software for the Space Shuttle program to developing softare for the Space Station program, where the product and the program environment are very different, but the quality requirements are the same. Another challenge is to apply the lessons we've learned about developing software to other business processes, like finance, administration and human resources.

We actually began doing this three years ago. What we've learned is that the same principles apply, no matter what the process. You can expect improvement whenever you give employees control over their own processes and hold them accountable for the results.

Take employee education and training, for example, a process that is very different from software development. Our education department staff found ways to increase the amount of education and training our employees receive 28 percent and at the same time reduce costs almost 30 percent. Best of all, our employees tell us that they are nearly 100 percent satisfied with the training and education they are getting.

A great deal of the progress we've made in improving our processes since 1987 can be traced to our decision to apply for the NASA quality award and other quality awards.

No one who has ever applied for the award says it's easy. The criteria are comprehensive, rigorous and based on the highest standards. They are very similar to those used for the Baldrige Award. The judges are trained, objective, third parties, and they are not easily fooled.

Applying for the award is one of the best opportunities you'll get to assess your products, your processes and your basic assumptions about doing business. The simple act of answering the

questions forces applicants to shine a light on every part of their business, highlighting strengths and exposing weakness. You'll be left with few illusions.

The application process also provides an excellent opportunity to compare your performance against your competitors, something I think we all naturally avoid.

All in all, applying for the George M. Low Trophy can be a humbling experience. And that's good. A thorough and informed evaluation by an unbiased third party (who also happens to be your customer!) can provide a tremendous impetus for change inside your organization. It may provide exactly the leverage you need to get the attention of some parts of your organization who want to maintain the status quo and conduct "business as usual."

Just the fact that you've applied for your customer's quality award sends a clear message to NASA, to your other customers and to your employees that you're serious about quality. It draws a line in the sand that shows everybody exactly where you stand. It's not a process for cowards.

In many ways, my company felt that we had a responsibility to apply for the award and do everything we could to help make the program a success. During a time when NASA's image is tarnished somewhat in the eyes of the public --compared to feelings, say, twenty years ago --- we believe that a strong George M. Low Trophy program reinforces NASA's image as a quality organization, an image that reflects well on all federal contractors.

I can honestly say that applying for the NASA quality award was one of the best decisions we ever made. We're making no assumptions about this year. As I said, the customer's gotten tougher and the competition's gotten smarter. But even if we don't win, we believe that the experience already has paid off in a hundred different ways. It's a process that I recommend highly to any NASA contractor.

THE GEORGE M. LOW AWARD – THE BUSINESS RATIONALE

George R. Faenza, Vice President – General Manager

McDonnell Douglas Space Systems Company – Kennedy Space Center

The business rationale for investing time and resources in pursuing the George M. Low Award is simple: It makes good business sense for today and for the future.

My teammates at the Kennedy Space Center division of McDonnell Douglas Space Systems Company and I view the process of applying for this award as an integral part of our continuous improvement journey. The George M. Low Award process provides an outstanding opportunity to ensure customer satisfaction through quality and productivity improvements, and strengthens our partnership with our customers and suppliers. The award also strengthens our competitive position by building our credibility relating to being a world class producer of quality products and services.

The process of applying and qualifying for the George M. Low Award has served as a catalyst in our continuous improvement process in five major ways:

1. It has provided us a disciplined approach to self assessment, bringing our strengths and weaknesses into view immediately.

2. The process of preparing our application report and preparing for the site visit by the Validation Team has significantly increased our employees', suppliers', and customers' buy-in and participation in our continuous improvement process.

3. We have benchmarked ourselves against the award criteria and the processes of previous award winners, giving us significant new data to use in our quality journey.

4. The Site Visit Validation Team's supportive feedback methodology has proven to be very valuable in measuring our progress toward total quality management relative to our in place processes.

5. Being a finalist for the George M. Low Award has enhanced our customers', suppliers', and competitors' recognition of our quality and productivity achievements.

We recognize that, in the highly competitive and dynamic environment of our nation's space program, customer satisfaction and the quality of products and services are the most critical parameters to sustained growth. With this in mind, we embarked on our quality journey to effect quantifiable, bottom-line benefits to our customers and the corporation using the application process for the George M. Low Award as a critical step.

Our quality journey formally began in the early 1980's with then MDC Chairman Sandy McDonnell's introduction of the Five Keys to Self-Renewal: ***Strategic Management, Human Resources Management, Participative Management, Productivity and Quality***, and ***Ethics***. These Five Keys to Self-Renewal have provided the framework of our quality journey over the years, and serve as the rim of our McDonnell Douglas Space Systems Company (MDSSC) total quality management (TQM) model, as illustrated in Figure 1.

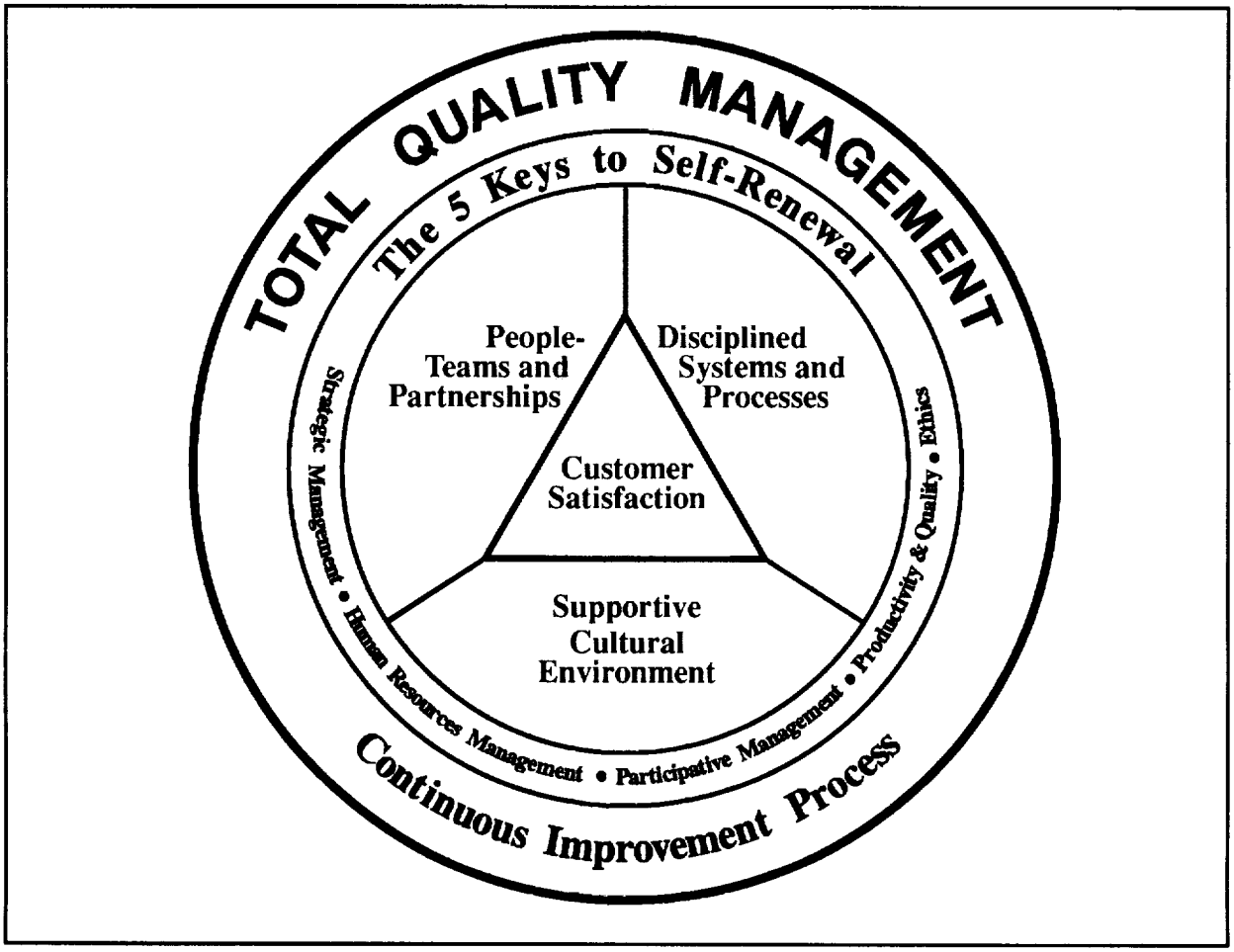


Figure 1 **MDSSC–KSC Total Quality Management Model**

In 1989, our chairman initiated a corporate-wide cultural change to enhance customer satisfaction through total quality management. ***Customer satisfaction***, represented at the center of our MDSSC TQM model, has always been the foundation of our Kennedy Space Center division's involvement in the space program. As NASA's Payload Ground Operations Contractor, the MDSSC-KSC team is responsible for the ground processing of all payloads that fly on the space shuttle and for providing expendable launch vehicle support for NASA and the Department of Defense. Of paramount importance to customer satisfaction is our partnership with our external and internal customers. We use these partnerships as the stepping stone to producing quality products and services, using the three elements of TQM that lead to customer satisfaction: ***people – teams and partnerships***, ***disciplined systems and processes***, and ***a supportive cultural environment.***

People – teams and partnerships, represented on the left side of our TQM model, stress the importance of working as a team with each other, our customers, and our suppliers. ***Disciplined systems and processes***, represented on the right side of the model, provide the structure for directing, implementing, and measuring our quality and productivity improvements. The base of the model represents ***a supportive cultural environment***, which ensures that our teammates have the tools and training they need to make empowerment work and to do their jobs well. When implemented by each of the individuals across the division, these elements produce the products and services that satisfy and delight our customers.

As part of our business rationale, we have applied for the George M. Low Award twice, with different expectations about the benefits of participating in the process each time. In 1990, we wanted to reap the benefits of applying to learn where we were in our quality journey and what we should do to get where we would like to be. In 1992, we wanted to measure our specific progress by benchmarking our processes against the award criteria.

From a business standpoint, we expect to realize three long-term benefits of our participation in the George M. Low Award process: **(1) a greater ability to sustain the growth of our business, (2) an enhanced ability to recruit and retain highly-qualified employees**, and **(3) enhanced prestige among our customers and competitors**. These benefits form the foundation of our long term business rationale.

We are already receiving a number of unexpected benefits from being named a finalist this year. The process of preparing for the site visit by the Validation Team involved a significant number of our nearly 2,000 employees who support NASA's Payload Ground Operations Contract. As each day brought us closer to the site visit, more and more of our teammates became involved and began to share in the excitement of telling the MDSSC-KSC story to representatives of NASA and the ASQC. This excitement still prevails as we await the final selection by the NASA Administrator.

The motivation, commitment, and pride that every leader wants in his people have become an integral part of our team's day to day attitudes and activities. We now have increased buy-in from our employees and our customers and a heightened level of unity and commitment from all involved. We have a shared focus and increased pride in our accomplishments, which has led to greater enthusiasm and excitement about our continuous improvement efforts. All of these unexpected benefits have given us the momentum to sustain our excellent performance – to continue on our quality journey and to ensure that we are delighting our customers. One of the greatest benefits we have received from applying for the George M. Low Award is clearly that the NASA/MDSSC-KSC team partnership has been significantly strengthened by this process.

Was the investment worth it? Absolutely! Specifically, the process has validated the progress we are making on our journey towards total quality management, and we are using the feedback from the Validation Team as an integral part of our continuous improvement process. The bottom line is that our pride in our achievements and shared focus on sustaining these quality and productivity successes have strengthened our team and have strongly enhanced our partnership with our NASA customers, and this in turn validates our business rationale for investing time and resources in pursuing the George M. Low Award. Simply stated: It's good for business – for today and for the future.

3.0 THE GEORGE M. LOW TROPHY--THE BUSINESS RATIONALE

Panel 3 - 1992 George M. Low Trophy Finalists - Small Business

The speakers for this panel are 1992 George M. Low Trophy finalists. The chairman represents a former George M. Low Trophy recipient organization. They will discuss the business reasons that motivated their organizations to participate in the George M. Low Trophy program.

Thomas S. Marotta, Chairman and President, Marotta Scientific Controls, Inc., **Chairman**

Rebecca J. Caldwell, President, Technical Analysis, Inc.

John J. Schwartz, Vice President, NASA Programs, Stanford Telecommunications, Inc.

PANEL 3 - 1992 GEORGE M. LOW TROPHY FINALISTS - SMALL BUSINESS

Thomas S. Marotta, Chairman and President
Marotta Scientific Controls, Inc.

Good morning, I would like to welcome all of the attendees to this session of the George M. Low Trophy and a special welcome to this year's Small Business Finalists: Technical Analysis Inc. represented by Rebecca Caldwell and Stanford Telecommunications Inc. represented by John Schwartz.

I am also pleased to see greater interest and activity by the many small businesses attending this Conference. Small businesses have contributed so much to America's past accomplishments in space. As NASA's first recipient in the Small Business category for the George M. Low Trophy, I would like to take this opportunity to encourage other small businesses to apply for this prestigious award, and I would like to congratulate our two 1992 Small Business Finalists for they have already received recognition by their peers for having passed NASA's and ASQC's rigid quality requirements.

Permit me to set the stage by telling you a little about Marotta. Marotta Scientific Controls was started by my father, Patrick T. Marotta, in the basement of his home and garage almost 50 years ago. At the present time we have 250 employees operating in, what we feel, is a state-of-the-art facility in Montville, New Jersey. In this facility we design and manufacture high-performance valves, fluid control products and systems for specialty liquid and gas control applications.

We believe our success over the years has been based to a great extent on formalizing the quality culture that was developed by my father in the early 1940's.

During the short time we have this morning I would like to focus on the benefits that Marotta Scientific Controls has received as a result of participating in NASA's Excellence Award for Quality and Productivity program, and what we have accomplished since winning the George M. Low Trophy two years ago.

The participation process formally rated our activities against NASA's Excellence Award criteria. Marotta, as with other small businesses, rarely takes the time to formally rate and evaluate our performance against a nationally recognized criteria. This process is extremely valuable because the strengths and weaknesses are exposed so that strengths can be reinforced and opportunities for improvement can be addressed.

We did not enter to win, but there were many benefits to winning. Exposure to potential new customers, improved recognition of our quality standards, an active dialog with other quality companies

including Malcolm Baldridge winners, and, of course, a very positive impact on employee morale.

What has Marotta accomplished in the past two years as a result of winning the award? The first task for me was to learn how to make polished presentations before quality professionals without spending a great deal of time and money. NASA personnel was aware of the limited resources of a small business and were careful not to commit my company to more than a few presentations during the year. However, as the year wore on I began to enjoy making these presentations and wound up making six in the United States, one in Mexico and one in Germany. All of my presentations were made at quality seminars with Malcolm Baldridge winners or examiners.

The second task was to plan and implement improvements to my company's technical and engineering capabilities. In the past there has been a tendency by companies who won major quality or performance awards to slacken their efforts resulting in a loss of business. I was determined that this would not happen to my company.

In the past two years we have increased our engineering capability by over seventy (70%) percent. We have replaced or upgraded all of the CAD/CAM hardware and software. In addition, we intensified our Research and Development programs and upgraded our business systems and training programs. These investments enabled us to develop new capabilities in:

- o bi-latch solenoid valves
- o advanced solenoid design systems and materials
- o cryogenic valves
- o low pressure-drop ball valves
- o advanced electromechanical actuators
- o motorized valves
- o advanced electronic control systems
- o advanced seat technology
- o mathematical modeling - both components and systems

The results have been most gratifying. We have improved our gross margins by sixteen (16%) percent in the past two years and our aerospace business has more than doubled, and now represents approximately twenty-five (25%) percent of our sales.

In preparing for this short talk I tried to make a list of things that Marotta had done to achieve a high level of quality and productivity. I was able to categorize these into five areas which I believe will address how a small business can achieve a position that enables it to get more than its share of awards. The five areas are:

1. Leadership and commitment from top management.

2. Performance measurements and standards.

3. Training.

4. Communication.

5. Employee empowerment.

As you can see, we have used the NASA Excellence Award's experience to benefit our employees, our company and our customers.

Thank you.

Applying for the George M. Low Trophy - The Business Rationale

James H. Wiggins-P.E., CSP, Executive Vice President,
Technical Analysis Incorporated

INTRODUCTION

Technical Analysis Incorporated is a woman-owned, small business providing services in product assurance engineering. Our main areas of business are in performing safety, reliability, maintainability and quality engineering services for NASA, ESA, DOD and commercial customers. We also perform special studies and training specifically tailored to customer needs.

Our business reasons for application for the George M. Low Trophy are founded upon the reasons for our existence as a corporation. From the beginning, we believed we could make a difference for our customers. I had seen customer dissatisfaction with the cost and the effectiveness of results they were given when they hired companies to assist them in their product assurance tasks. I believed we could perform these tasks more quickly, at less cost and still achieve a high degree of quality in the product delivered. The company was founded upon these customer satisfaction principles.

We are driven to achieve the very best results and advice for our customers. We are also a business and are, therefore, motivated to return a profit. However, profit is not our driving force. We have offered on several occasions to work for no profit if the customer felt that was in their best interest.

Our Total Quality Management Process, QEST -Quality Products, Excellent Service, Satisfied Customers, Teamwork- embodies our philosophy and was started to evaluate how we as an organization could increase our efficiency. QEST was the result of some thought and discussion applied to:

- Where do we need to be for the future
- Where are we now in reference to need
- How can we get from where we are to where we must be

We believe the QEST process will provide us guidance in each of these three areas and, simultaneously, provide our customers with a product quality that is not reached by our competitors. In 1990, QEST was formalized and has worked well in providing the basis for stepping off into other areas.

The George M. Low Trophy application was a required step for our company for several reasons, not all of which were known when we started. I guess you could say we have gotten smarter as we participated in the process.

RATIONALE FOR APPLYING FOR THE GEORGE M. LOW TROPHY

While QEST had worked well in some areas, it had focused on corporate policy evaluation and change, which enhanced personnel understanding and commitment to these policies and the company. Our QEST Forum efforts resulted in either changes to policy, clarifications or a reaffirmation of the policy and why it was important.

QEST Forums had not tackled the complex and difficult task which is essential to placing the company in a better competitive position and, thereby, contributing to its long-term existence. The task to which I refer is the evaluation of our service tasks, the heart of developing customer products. We had touched on the fringes and had produced limited results with little effect.

Our Culture Surveys had indicated that our corporate level perception of the company was not that held by the employees. Some immediate actions were taken to change these perceptions. However, we needed to know where we really stood in achieving the goals of quality -- where we were, where we needed to be, and how we could get there. We also needed some rejuvenation of spirit and motivation for everyone. The George M. Low Trophy application provided us the opportunity to:

- Conduct a significant internal review of our status against requirements
 - Involve everyone somehow in this evaluation process
 - Focus attention and effort on customer satisfaction issues
 - Focus attention on the employee and their everyday work result
- Obtain an objective, fresh assessment of our status
 - Initial review of the application and feedback by the NASA/ASQC Team
 - Fact-finding visit to Houston, Texas and feedback
 - Major Site Visit to Huntsville, Alabama and feedback
 - Site Visit debrief
 - Our detailed preparation for these visits resulted in more internal knowledge as to our status of quality achievement.

- Share in the Information Environment
 - Contact with other firms to gather information on their best efforts with the goal to implement what we could.
 - Learn from companies with many more resources than what we have.
 - Tell others what has worked for us and what has not.
 - Candid and constructive communication between ourselves and our external customer.
 - Candid and constructive communication between employees and management - our internal customers.
- Positively affect the Process
 - Internal awareness enhancement
 - Internal motivation to evaluate our process
 - External feedback
 - Opportunity to assist others

Results Achieved

To date - the beginning of this conference - I can report positive results and feedback in several areas:

People

I believe, and our feedback indicates the validity, that the application process has had a significant and very positive impact upon our people at all levels of the company. Awareness of our finalist status and the feedback received by each of us has validated the hard work of each person in the company. As Dr. Deming has stated, "It isn't how hard you work, but how smart you work". We at Technical Analysis Inc are getting smarter and better at what we each do.

Environment

The openness of communication has given each person the understanding that we care about how we do our tasks and what we deliver. There is a higher sense of teamwork and willingness to contribute. No subject is taboo for discussion, evaluation and change. People feel they can make a difference.

Resources

We are a small company with limited resources. However, the need to place a focus on automation of work process has been amply demonstrated to us by our own investigation during application and site visit preparation. The need for better and specific tools, equipment, and methodology has also been emphasized by the George M. Low application process.

In closing, I wholeheartedly endorse the George M. Low Trophy Award process as a significant means to increase the quality of a company. As a result of our participation, we have identified and are correcting areas for improvement in our company, which can only help us continue to be a company. We have developed new policy and procedures, started new evaluation efforts and refocused our enhanced motivation to succeed in customer satisfaction.

Continuous Improvement at Stanford Telecom

John J. Schwartz, Vice President, Stanford Telecom
Susan M. Chang, Department Manager, Stanford Telecom
Andrew J. Musliner, Engineering Specialist, Stanford Telecom

Company Overview

Stanford Telecom is a publicly held company with its corporate headquarters located in Santa Clara, California. Founded in 1973 by the current President and Chairman of the Board, Dr. J. J. Spilker, Jr., Stanford Telecom now employs a staff of over 900 employees at eight facilities throughout the United States. Fiscal year 1992 revenues were approximately $95 million.

Stanford Telecom is a leader in the application of state-of-the-art technology to the systems engineering, design, development, manufacture, and support of electronic systems operating as elements of space-based navigation, communications, and surveillance systems. The company produces systems engineering studies and analyses, as well as hardware and software products including digital receivers, high performance modulation and demodulation equipment, satellite tracking and control systems, network control systems, and complete satellite earth terminal systems.

The Systems Engineering Division at Stanford Telecom

Stanford Telecom's System Engineering Division (SED) was established in 1976 by Mr. Leonard Schuchman to perform systems engineering in support of the Federal Aviation Administration (FAA), the Department of Defense (DoD), and NASA.

SED began supporting NASA in 1977 as a Tracking and Data Relay Satellite System (TDRSS) contractor to the Goddard Space Flight Center (GSFC). Since that time, SED support for NASA has grown to include systems engineering support for both the TDRSS and TDRSS II space network elements, the Second TDRSS Ground Terminal (STGT), the Communications Link Analysis and Simulation System (CLASS), and other engineering support efforts at NASA's Lewis Research Center, Marshall Space Flight Center (MSFC) and Jet Propulsion Lab. Currently, of the 240 SED employees in three metropolitan Washington, D.C. offices (Reston, Virginia; Seabrook, Maryland; and Washington, D.C.), approximately 50 percent support NASA programs.

A Reputation for Excellence

Over the past 15 years, Stanford Telecom's Systems Engineering Division has earned an outstanding reputation for contract performance, providing NASA GSFC with exceptional systems engineering support and quality products on schedule and within cost. This reputation is reflected in the numerous NASA achievement awards we have received:

- First annual NASA GSFC Contractor Contribution Award (1989)
- Four SBA Administrator's Award for Excellence (USAF/RADC, 1988; SDI Effort, 1989; Space Station, 1991; TDRS II, 1992)

- NASA GSFC Excellence Award for Quality and Productivity Finalist (1990, 1991, 1992)
- NASA's Group Achievement Award (COBE Project Team, 1990)
- NASA's Public Service Group Achievement Award (1991)
- Two SEAS Subcontractor Group Achievement Awards (CLASS, March 1991; STGT, October 1991)
- George M. Low Trophy: NASA's Quality and Excellence Award Finalist (1992)

Further attesting to our creativity and innovative spirit are the 18 Small Business Innovative Research (SBIR) grants won during the 30-month period when we were eligible for such grants. During this time we won 11 phase I awards (5 of which were NASA), 6 phase II awards (3 of which were NASA), and 1 NASA phase III award.

Additionally, in just the last three years, our efforts have been recognized through the receipt of more than 30 letters of commendation from the various NASA customers, award fees averaging 95% on the Space Network Systems Engineering (SNSE)[1] contract, and more than 100 "plus point" event evaluations for our efforts on projects under the Systems Engineering and Analysis Support (SEAS) contract.

All of these awards and commendations stress our technical expertise, exceptional level of performance, and contract responsiveness. It is primarily on this record of excellence at NASA GSFC that we base our application for the George M. Low Trophy.

Operating Principles

Since its inception in 1976, SED has emphasized excellence in contract performance as the number one goal. Specifically, we stress technical excellence and innovation, producing quality products on time and within cost, and customer communication and satisfaction. Our success in accomplishing these objectives is primarily due to the fact that we concentrate on work that is interesting and challenging to all employees, attract and hire the most skilled employees, and encourage employees to work with others in a team environment. We try hard to provide work with the maximum potential for growth consistent with employees' desires and capabilities. Similarly, care is taken to staff tasks with people that not only possess the necessary training and skills but that can also work together as a team with enthusiasm, mutual respect, and a spirit of cooperation.

To help foster an enthusiastic work environment, SED stresses the importance of the individual within the organization. It is critical not only that each employee enjoy his/her work, but that he/she feels the worth of his/her individual contribution to the team, the company, and the customer. SED is a people-oriented organization, and the importance of the individual is never ignored.

An open door policy exists between employees and all levels of management. This policy provides for a high level of information transfer, a true team atmosphere and the development of quality

[1] Systems engineering support to TDRSS II Project.

products. As cooperation is a key to daily operations and the advancement of corporate objectives, SED managers and task leaders work directly with task engineers to define and develop products. A cooperative atmosphere is furthered by open and continuous dialogue with the customer. This ongoing interaction, both within the company and between the company and its customers, helps ensure complete customer satisfaction.

Continuous Improvement at SED

Continuous Improvement (CI) at SED has, over the years, been a highly effective yet informal process. In the past, because our division was sufficiently small, this "oral" tradition for promoting an atmosphere of teamwork, cooperation, quality, and technical excellence has served us well. The SED corporate objectives laid the groundwork for these informal CI methods:

> *"Our work must be of outstanding quality for it is our work that is our reputation. We ask all to work hard and efficiently to build the company, but it is only with an enthusiastic team effort and spirit of cooperation that our work can also be enjoyable."*

And our corporate awards and letters of commendation attest to its effectiveness. But as our company has grown, so has our need to formalize this process of CI.

Consequently, we recently began implementing a formal CI program at SED. In our application for the 1992 George M. Low Trophy, we identified our goals and schedule for implementing a formal CI program at SED. In April, 1992, we initiated the preparation of a formal implementation plan which was completed on schedule and approved three months later. SED-wide implementation of this plan is to be completed and in place by the end of our fiscal year (March 31, 1993).

A key to the development of the SED CI Program was its development in-house, by all levels of management and employees. Rather than utilize a consulting firm or other outside source, we chose to design and implement the plan ourselves. This enabled us to easily tailor the plan to maintain an informal approach in keeping with the SED corporate philosophy. It also enabled us to gear it towards SED division objectives, and address specific needs of our NASA and other government customers.

Our CI program described below is based upon lessons learned from our West Coast Manufacturing and Quality Assurance Group (MQA) and discussions and reviews of Total Quality Management (TQM) and CI programs already in place at other aerospace companies. Some of the primary concepts included in the SED CI Plan based on these discussions were the inclusion of a "process improvement" committee, the employee suggestion program, the outward commitment of upper management to the CI Program, task improvement initiatives, and customer satisfaction measurements.

SED CI operates at two levels: division-wide and task-level continuous improvement. At both levels the plan is a voluntary one, relying on the individual employee's ongoing desire to improve quality and productivity for the betterment of his/her work environment and the company as a whole.

Division-level CI: The SED CI Program

The principal vehicle for continuous improvement at the division level is the SED CI Program. The CI Program provides a mechanism through which employees, empowered by their own ideas and creativity, can voluntarily make improvement suggestions which lead to higher quality products, greater productivity, a greater competitive edge, a higher quality worklife, more effective methodologies, and improved efficiency. The SED CI Program is comprised of the following:

- A CI Steering Council
- A CI Coordinator
- Five CI Committees
- Quality Action Teams
- A Suggestion Program.

The CI Steering Council is chaired by Mr. Leonard Schuchman, Senior Vice President and General Manager of SED and is comprised of the division vice presidents. The CI Steering Council provides the overall strategy for handling process improvements that are reported by the CI Committees.

The CI Coordinator reports directly to the CI Steering Council Chair and serves as the main point of contact between the CI Steering Council and the five CI Committees listed below:

- Customer Satisfaction Committee
- Quality of Worklife Committee
- Training Committee
- Recognition and Awards Committee
- Process Improvement Committee

Each of the five CI Committees is comprised of a minimum of five employees (with representation from all SED facilities), co-chaired by a sponsor (a Division Program Manager), and a facilitator, who is a member of the SED staff. The CI Committees perform the majority of the work for the SED CI Program, as they are responsible for outlining responses and acting on improvements proposed by the employee through the CI Suggestion Program.

The CI Suggestion Program, at the heart of the SED CI Program, offers every employee the opportunity to propose improvements. In keeping with the SED philosophy that the importance of the individual is foremost, this program relies on the individual employee for advancing the quality and productivity of the division as a whole. A successful Suggestion Program results in more efficient utilization of assets, increased productivity, a reduction of waste, lower product costs, and improved quality. For the employee, the Suggestion Program offers a means for self-expression and a path toward achievement, recognition, and contribution.

However, for the Suggestion Program to be successful, staff members must know that their suggestions are being considered seriously by the CI Committees and acted upon by the CI Steering Council in a timely manner. To these ends, a simple CI Idea (CII) form was developed to both formalize the suggestion process and provide a means for accurate tracking of employee suggestions throughout the CI approval process. The final decision on each suggestion is given directly to the staff member who submitted the suggestion (if a name was provided) as well as in a quarterly newsletter. Placards with a supply of the CII Forms are located at each SED facility.

The SED CI Program works according to the diagram in Figure 1. An employee submits a suggestion on a CII form to the CI Coordinator who assigns it to an appropriate CI Committee based on its area for suggested improvement. The CI Committee, which meets once a month, then assesses the applicability of the suggestion and takes appropriate action based on research into the topic and recommendations from the CI Steering Council. For particularly complex improvement issues, a CI Committee may form a Quality Action Team to address the problem. Such a team is dissolved upon the completion of its work. Throughout the process, the employee is kept informed as to the status of his/her submitted CII.

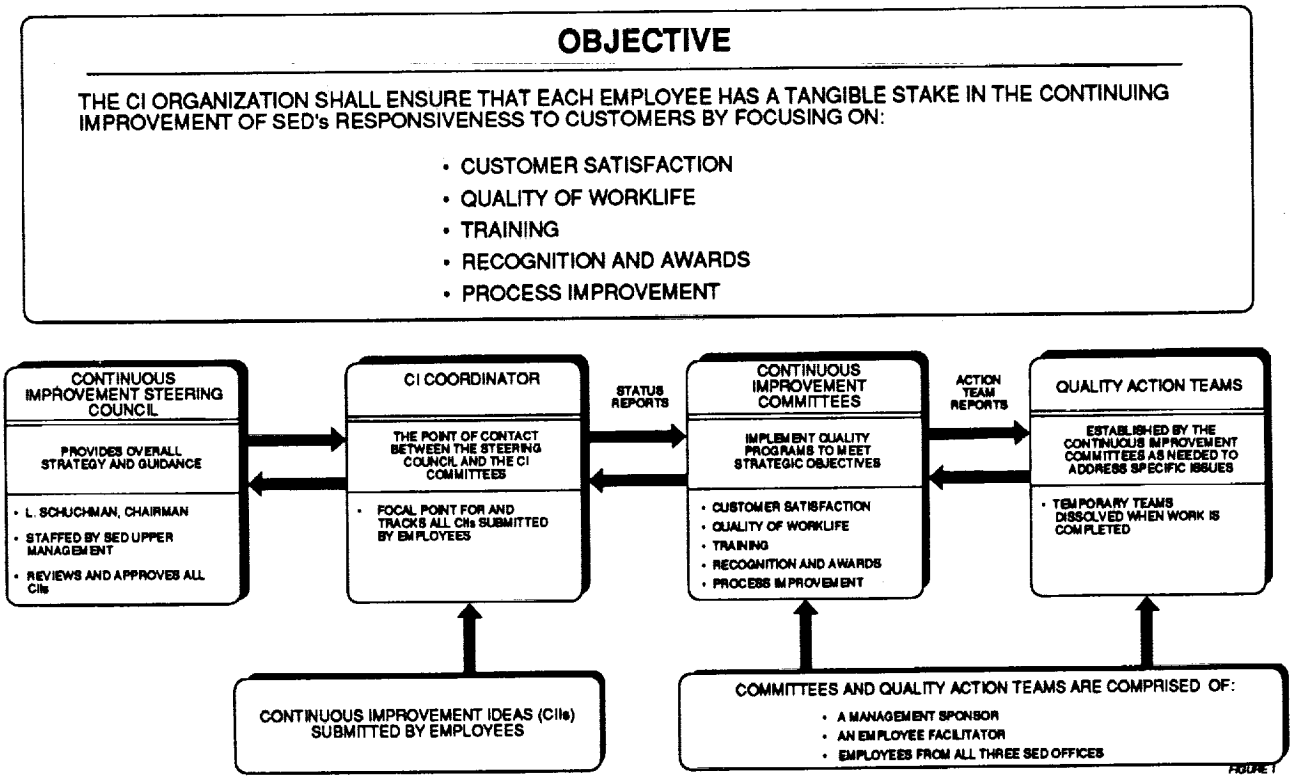


Figure 1. SED CI Program

Task-level CI: The Task Improvement Initiative and Customer Feedback

Task-level continuous improvement is implemented through the use of the Task Improvement Initiative (TII) and the Customer Feedback Monthly Evaluation Form.

TII is a formal suggestion program similar to that under the division-level CI Program, but is aimed at task-level improvement rather than office-wide or division-wide enhancement. It encourages the employees to devise new methods, and effectively revise existing techniques to improve their own work processes.

A Task Improvement Initiative starts with an employee and an idea for task quality improvement or process enhancement. The employee who originated the idea brainstorms with his/her co-workers to help determine the feasibility of the idea. Then, with the task manager's approval, the TII is proposed to the customer who also must give his/her approval prior to the implementation of any task-level policy or procedure changes. With customer approval, the TII is implemented, leading to task cost avoidance, improved quality, and/or an improved schedule.

Customer satisfaction is paramount to success, and customer satisfaction cannot be achieved without quality services rendered. Consequently, SED quality is maintained and continuously monitored through effective communication with our various customers. Mutual understanding and cooperative goals can only be achieved through such close interaction, and thus we welcome continuous customer feedback.

One of the ways we, as a contractor, receive customer feedback on our efforts is through the customer's use of the Monthly Evaluation Form. This form enables the customer to provide direct feedback to us on significant events that have occurred over the course of the past month. The form acts as a forum for both problems and praise, using the -/0/+ point system to indicate task event performance. In this manner, we are able to readily address any issues the customer may have with our performance, as well as recognize and/or award those individuals who contributed to a significant "plus (+) point" event report. The Monthly Evaluation Form ensures that our quality is consistently monitored, and that customer satisfaction is maintained.

Application Rationale / Lessons Learned

Applying for the George M. Low Trophy, NASA's Quality and Excellence Award, affords us a unique opportunity to utilize an objective measure of our operations to advance a series of corporate and business objectives. Simply recognizing the requirements necessary to apply for the Trophy has helped us improve corporate procedures, streamline corporate processes, and isolate areas in need of further improvement. Most significantly, the Trophy has helped reinforce management commitment to the concepts of continuous improvement and the formal SED Continuous Improvement Program.

Becoming a George M. Low finalist has already begun to positively affect the workplace at SED, reinforcing the decision to apply for the award. The Trophy has had a profound effect on corporate team spirit, boosting employee pride and morale as it helps demonstrate that the quality of our work is among the best in the aerospace industry. In the long run, we hope that this award will help further our business objectives by helping to attract and retain quality professionals to the organization and increase teaming opportunities.

Conclusion

Stanford Telecom has long been an advocate of continuous improvement, as evidenced by our corporate objectives and long list of awards and commendations. Today, we find ourselves at a crossroads, attempting to maintain the informal atmosphere that has been the driving philosophy of the corporation since its founding, while at the same time implementing a formal plan for process improvement: The Continuous Improvement Program. With total management commitment and

an enthusiastic staff, we feel we are meeting this challenge. Implementing a formal mechanism while still relying on the individual for process and worklife improvement will provide us with a unique opportunity to improve quality throughout the Stanford Telecom SED organization.

A Total Quality Assessment and Measurement

These panels will explore contemporary and breakthrough assessment and measurement of organizational effectiveness. Emphasis is placed on Total Quality Management processes which foster world class quality, productivity, customer satisfaction, and bottom-line results.

A1 Using Award Criteria to Improve Organizational Effectiveness

This panel compares and contrasts public and private sector award quality award criteria. Approaches to assessing and measuring quality and productivity improvements using these criteria are presented through two case studies.

Larry D. Lambert, Senior Vice President, American Productivity and Quality Center, **"Measuring Quality Progress"**

Dr. David L. Stoner, Manager, Technical Support, Loral Space Information Systems, AND **Susan A. Braymer**, Director, Human Resources Development, Lyndon B. Johnson Space Center, **"Defining the Performance Gap: Conducting a Self-Assessment."**

Brenda M. England, Manager, Engineering Process Improvement, Hamilton Standard Division, United Technologies Corporation, **"Closing the Gap: Using NASA's Quality and Excellence Award Criteria as a Self-Evaluation Tool."**

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Measuring Quality Progress

Larry D. Lambert, Senior Vice President
American Productivity and Quality Center

N94-13154

Executive Summary

Study Approach

This study by the American Productivity & Quality Center (APQC) was commissioned by Loral Space Information Systems, Inc. and the National Aeronautics and Space Administration (NASA) to evaluate internal assessment systems. APQC benchmarked approaches to the internal assessment of quality management systems in three phases.

The first phase included work conducted for the International Benchmarking Clearinghouse (IBC) and consisted of an in-depth analysis of the 1991 Malcolm Baldrige National Quality Award criteria.

The second phase was also performed for the IBC and compared the 1991 award criteria among the following quality awards: Deming Prize, Malcolm Baldrige National Quality Award, The President's Award for Quality and Productivity Improvement, The NASA Excellence Award (The George M. Lowe Trophy) for Quality and Productivity Improvement and the Shigeo Shingo Award for Excellence in Manufacturing.

The third phase compared the internal implementation approaches of 23 companies selected from American industry for their recognized, formal assessment systems.

Major Study Findings

1. All of the five quality awards considered in this paper have major differences in their award criteria and scoring guidelines. While the 1991 Baldrige Award Criteria were considered the most complete of the five awards, there is still room for improvement in the areas of process control and quality results.

2. The weighting of the categories among the various awards indicates their focus for applicant recognition: The Shingo Prize recognizes companies that focus on process control at the shop floor level with half of its points awarded in this area, while the Baldrige Award, President's Award and NASA Excellence Award, recognizes a broader area of quality performance. The Deming Application Prize uses a prescriptive criteria system but applies the same criteria to all areas of the company to achieve breadth of application for its criteria.

3. The 1992 Baldrige Award Criteria have strengthened the Examination Items noted as areas for improvement in paragraph 1 above.

4. Of the 23 companies whose internal assessment programs were evaluated, five used self-assessment surveys, one used a combination of self-assessment survey with an internal Baldrige-like assessment, nine used the Baldrige Criteria and approach without modification, and eight customized the Baldrige process or criteria for their own internal application.

5. The biggest area for improvement in internal company assessment systems is the calibration of individual examiner scoring. One company reported point spreads greater than 400 points among examiners. This is consistent with the scores of individuals who have been initially selected for the Malcolm Baldrige National Quality Award (MBNQA) Board of Examiners, but who have not yet attended training. One intent of the MBNQA examiner training is to calibrate the Board of Examiners on recognizing the 50% level of performance using the scoring guidelines.

Study Objective

Background

In 1987 President Ronald Reagan signed the Malcolm Baldrige National Quality Improvement Act which established a national award to recognize quality improvement among manufacturing, service, and small businesses. The act did not describe the scoring system, judging process or criteria for evaluation of applications. These criteria have become an operational definition of Total Quality Management (TQM) and the wide distribution of the application guidelines has exposed many senior managers to the "Baldrige" definition of TQM.

The Malcolm Baldrige National Quality Award was not the first prestigious quality award. That distinction goes to the Deming Application Prize of the Union of Japanese Scientists and Engineers. Initiated in 1951 and named after the W. Edwards Deming, the American quality guru who helped to begin the Japanese quality movement, the Deming Prize has been long recognized as an indicator of excellence in business. In a 1983 study by Dr. Noriaki Kano of Deming Prize recipients business performance compared with that of non-Deming Prize companies, it was observed that the Deming Prize winners had a 3-6% range of advantage in annual return on net assets, a measure of business profitability, over the non-winners from the same industry during the decade of the 1970's.[1]

While the Deming Prize is focused on statistical process control as the fundamental building block of quality (see the summary of the award criteria in Appendix A), the Baldrige Award applies customer satisfaction as the foundation of quality and applies quality methods to business management. Other quality and productivity awards have been introduced to recognize improvement in particular areas. and have slightly different intent and criteria. These other awards include:

- The President's Award for Quality and Productivity Improvement
- The National Aeronautics and Space Administration Excellence Award for Quality and Productivity (The George M. Lowe Trophy)
- The Shigeo Shingo Prize for Excellence in Manufacturing

These awards have stimulated interest in a United States business community which thrives on competitive recognition. David A. Garvin, a Professor of Business Administration at the Harvard Business School and a member of the Board of Overseers for the Malcolm Baldrige National Quality Award from 1988 to 1990, has described the Baldrige Award as "*the* most important catalyst for transforming American business."[2] The award provides a framework for management to assess their progress for achieving quality results that produce competitive performance. Indeed, the General Accounting Office (GAO) has published a report that

evaluates the business competitiveness of 20 companies who were high scorers on the 1988 or 1989 Baldrige Award applications. While the results of the GAO study were limited by the sample size, the GAO did conclude that there is a cause and effect relationship between the TQM practices embodied in the Baldrige Award Criteria and business performance as measured in terms of market share, productivity, and customer satisfaction.[3]

Purpose

This study was conducted by the APQC's International Benchmarking Clearinghouse staff in conjunction with the APQC Consulting Group. It was commissioned as a project to help the National Aeronautics and Space Administration assess their approach and criteria for their Excellence Award for Quality and Productivity (The George M. Lowe Trophy.) The study analyzes the inter-relationships among the evaluation items of the Baldrige Award Criteria; assesses the similarities and differences among the various quality award criteria; and compares the approaches of different companies for incorporating internal self-assessment methods into their quality improvement approach.

Benchmarking Methodology

This study was conducted by evaluating open literature and presentations made by companies at quality forums where they presented the details of their quality assessment approach. This study uses information that was presented from 1989 through the present and may not reflect the most current approach of any particular company. However, the company information is considered to be representative of self-assessment methods using the Baldrige Award criteria approach. The study findings include both a matrix comparing company approaches and a summary of best practices which contains a detailed description of a model approach for integrating the Baldrige Award criteria into a company-wide assessment program.

Organizations Evaluated

The International Benchmarking Clearinghouse is a service operated by APQC to improve business competitiveness through a network of organizations dedicated to sharing improvement opportunities through benchmarking. During the design phase of the Clearinghouse, a survey of the 87 companies involved in establishing this benchmarking network was conducted. It was found that 74% of these companies were using the Malcolm Baldrige National Quality Award criteria for self-assessment, even though only 51% planned on applying for the award within the next five years. Of these companies 88% also ranked their competitive position as leaders in most of their markets.[4] Companies using benchmarking and applying the Baldrige Award criteria clearly perceive themselves as leaders in their respective markets.

The Baldrige Award Process

The Intention of the Baldrige Award

The Malcolm Baldrige National Quality Award is an annual Award to recognize U.S. companies that excel in quality management and quality achievement. The Award promotes: awareness of quality as an increasingly important element in competitiveness; understanding of the requirements for quality excellence; and, sharing of information on successful quality strategies and the benefits derived from implementation of these strategies. Up to two Awards may be given each year in each of three eligibility categories: manufacturing companies, service companies, and small businesses. The Award examination evaluates applicants according to a set of Criteria and scoring guidelines which are included in the Application Guidelines. These Criteria are designed to be a quality excellence standard for organizations seeking the highest levels of overall quality performance and competitiveness. These Criteria are reviewed and improved on an annual basis to reflect lessons learned during the evaluation process. The award is managed by the National Institute of Standards and Technology (NIST) and administered by the American Society for Quality Control (ASQC). The evaluation of applicants is conducted by a Board of Examiners who are nominated from the quality experts of business, professional and trade organizations, accrediting bodies, universities, and government. Members of the Board of Examiners must meet the highest standards of qualification and peer recognition. The Board of Examiners evaluates each application considering the context of the applicant's business factors, according to the Award Criteria, following a prescribed evaluation process, and using an established scoring guideline. Each of these elements of the Baldrige Award process is described in the following sections.

The Effect of Business Factors

While the Baldrige Award Criteria have been designed for their general application for evaluation of any company's quality system, independent of size, type of business, or market environment, it is recognized that the importance of individual business factor for a given company may influence the applicability of the items and areas to address, even for businesses of the comparable size or in the same industry. To give appropriate consideration to these distinctions, the application requests a four-page Overview, which does not count toward the page limit, that addresses key business factors that must be considered during the Award evaluation process. These business factors set the context for the interpretation of the entire application and are exceptionally important. Information that is important to consider as business factors include:

- Business structure of the applicant and relationship to parent company (if a subsidiary)
 Note: Subsidiaries should also include information that shows key relationships to the parent company: (1) percent of employees; (2) percent of sales; and (3) types of products and services.
- Size and resources of the applicant
- Types of major products and services

- Key quality requirements for products and services
- Nature of markets (local, regional, national, or international)
- Description of principal customers (consumers, other businesses, government)
- Competitive environment
- Applicant's position in the industry
- Major equipment and facilities used
- General description of the applicant's employment base, including: number, type, and education level
- Importance of and types of suppliers of goods and services
- Occupational health and safety, environmental, and other regulatory considerations
- Other factors important to the applicant

The Evaluation Process

The Baldrige Award evaluation process contains four stages: first stage review of the written application; consensus review of the written application; site visit review; and Judges final review. Each applicant receives a feedback report which describes assessment of the Board of Examiners as to the Strengths and Areas for Improvement for each Examination Item in the application. The feedback report states observations and evaluations, not prescriptions on how to improve the applicant's quality process. The feedback report is prepared after an application has been eliminated from further consideration at one of the four stages of review.

The first-stage review of the written application is conducted as an independent review by 5 or more members of the Board of Examiners. Each Examination Item is graded in accordance with the Scoring System. The Board of Examiners take the application at face value. They accept the facts as presented and, when questions arise, they record them for verification or clarification at the site visit. The Scorebooks from each evaluation are returned to NIST/ASQC and the Judges select the top-scoring applications for the consensus review. The written comments of the Examiners from the first stage review are used as the basis of the feedback report for applicants not selected for the consensus review.

The consensus review of the higher-scoring applications from the first stage review is conducted by a team of 5 Examiners lead by a Senior Examiner. Consensus is initiated by the team leader with a goal of achieving an agreed upon scoring value for each of the Examination Items after the team has debated the relative merits of the applicant's approach, deployment, and results for that item. This is a particularly important step in the Award process because consensus numerical scores play a major role in determining which applicants will receive a site visit and in determining issues for review during the site visit. In addition, the written comments of the Examiners from the consensus review are used as the basis of the feedback report for applicants that are not selected for site visits. Using these written comments, the Senior Examiner prepares a consensus report to the Judges, and the Judges select the top-scoring applicants for site visits.

Finalists in the Award process receive a site visit from a team of six members of the Board of Examiners, lead by a Senior Examiner. The team visits one or more sites (labs, plants,

offices) of the applicant to *clarify* uncertain points in the application and to *verify* that the information presented by the applicant is correct. There are five distinct steps in the site visit process:

1. Notification -- The Panel of Judges selects applicants for site visits and transmits the information to the Award Administrator who notifies the applicant and the appropriate members of the Board of Examiners.
2. Initial preparation -- The team leader works with the NIST observer, Award Administrator, team members, and the point of contact from the applicant to establish the agenda and logistics for the site visit. Members of the site visit team perform review evaluation materials and perform tasks as assigned by the team leader.
3. Final preparation -- The team holds a day-long preparatory meeting immediately preceding the site visit. They finalize the agenda and category assignments, review site visit issues, and prepare the site visit worksheet which addresses the issues that the team will evaluate. This meeting is not held at the applicant's site.
4. Conduct of the site visit -- The actual site visit begins with an initial meeting with the applicant. During this meeting the team leader presents the agenda and objectives. After this introductory meeting, the site visit team divides and performs the individual Category assignments. The team caucuses as often as necessary to ensure that all assignments are being implemented, all issues/questions are being adequately addressed, and that the schedule is being followed. When the team leader and members are satisfied that all issues have been clarified or verified, the team leader closes the site visit by holding a meeting with the appropriate applicant representatives.
5. Preparation of the site visit report -- The site visit team completes the site visit worksheet and a report of their findings and conclusions about each Category, including the strengths and areas for improvement. The team leader reviews these worksheets for completeness and prepares a "Recommendation to the Judges" worksheet.

Following the receipt of the site visit reports, the Judges meet for the final review to verify that the Baldrige Award process was followed, review the site visit reports, and make recommendations of the Award recipients. The Award Administrator forwards the Judges' recommendations to the Secretary of Commerce for selection.

Interpretation of the Criteria

Some consulting companies have hinted that there is a hidden agenda in terms of what the Judges and Examiners are seeking in a "Baldrige-winning" company. But, there are no secrets. One member of the Board of Examiners has even published a book which presents his version of the interpretation of the Examination Items and what the Examiners evaluate.[12] The Board of Examiners is seeking a company which represents a national role model for quality based on that company's approach and deployment of their quality program as well as the results that are attributable to that program. The essential elements of the Award Criteria are described in the Application Guidelines. Together, the following key concepts and core concepts define the infrastructure for the requirements of the Examination Items:

- Customer Driven Quality -- Quality is defined by the customer. Business fundamentals, such as design quality and defect or error prevention, which affect the customer should be part of the quality system.
- Leadership -- The senior leadership of businesses must create clear quality values and build these values into the way the company operates.
- Continuous Improvement -- Quality excellence derives from well-designed and well-executed systems and processes. Continuous improvement must be part of the management of all systems and processes. Companies need to communicate quality requirements to suppliers and distributors and work as a team to improve the performance of the entire business.
- Fast Response -- Shortening the response time of all operations and processes of the company needs to be part of the quality improvement effort.
- Actions Based on Facts, Data, and Analysis -- Companies need to develop goals, as well as strategic and operational plans to achieve quality leadership. Operations and decisions of the company need to be based upon facts and data.
- Participation by All Employees -- All employees must be suitably trained, developed, and involved in quality activities.

The 1991 Baldrige Award Criteria are summarized in Appendix B. It is important to understand the context in which these criteria are used. The Baldrige Examination is a two-part diagnostic system. The first part is the Criteria which includes the seven Categories which are divided into Areas to Address as well as the detailed description of these areas which are called the Examination Items. Taken together, the Criteria represent the "what" is to be evaluated. The second part of the diagnostic system, the Scoring System, represents the "how" evaluations are made.

The Examination is non-prescriptive. While it is based on the values and key concepts described above, the Examination does not prescribe the specific means (specific techniques, methodologies, or organizational structure) to demonstrate excellence. The Examination also emphasizes the integration of the entire quality system. The Examination Items represent a system of requirements. Thus, quality system integration is the result of a company establishing the linkages among the direct and indirect relationships between the Examination Items. A coherent quality system demonstrates how these linkages are put into practice. In the Findings of this benchmarking study, the relationships among the Examination Items are demonstrated using an Affinity Diagram.[13]

Scoring Guidelines

The Scoring System is based on three evaluation dimensions: approach, deployment, and results. All Examination Items require applicants to provide information or data relating to one or more of these dimensions. Each of the Examination Items is graded according to a scheme which considers the applicant's approach, deployment of that approach, and results demonstrated from that deployment. The specific interpretation of these dimensions is found in the following operational definitions.

"Approach" refers to the methods an organization uses to achieve the purpose described in the Examination Item. The Examiners consider such aspects of the approach as:

- The degree to which the approach is prevention-based
- The appropriateness of the tools, techniques, and methods chosen to meet the requirements
- The effectiveness of the use of the tools, techniques, and methods
- The degree to which the approach is systematic, integrated, and consistently applied
- The degree to which the approach embodies effective evaluation or improvement cycles
- The degree to which the approach is based upon quantitative information that is objective, timely and reliable
- The utilization of unique and innovative approaches, including significant and effective new adaptations of tools and techniques used in other applications or types of business

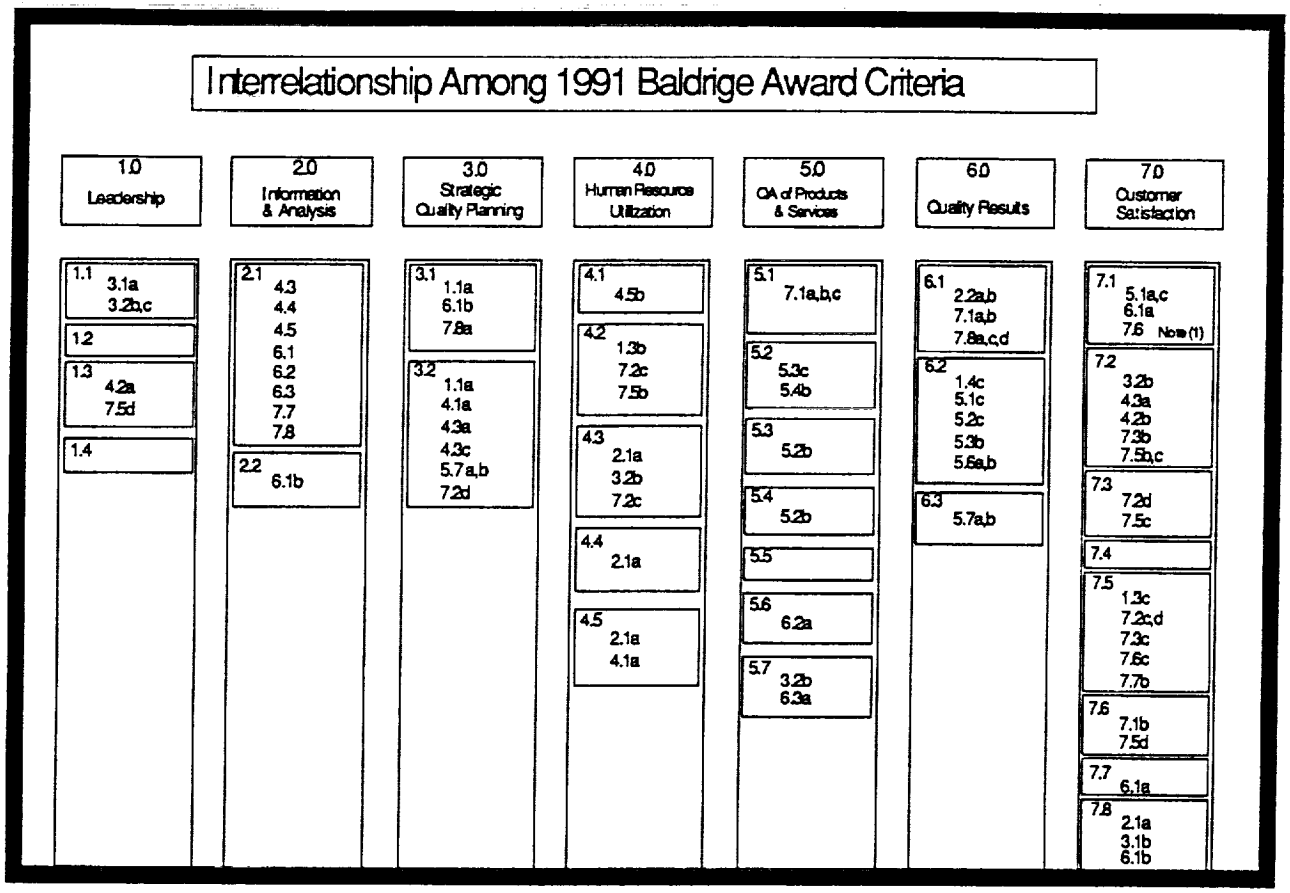
"Deployment" refers to the extent to which the approaches are applied to all relevant areas and activities which are either addressed or implied in the Examination Items. The Examiners consider such aspects of the deployment as:

- The appropriate and effective application to all product and service characteristics
- The appropriate and effective application to all transactions and relationships with customers, suppliers of goods and services and the public
- The appropriate and effective application to all internal processes, activities, facilities, and employees

"Results" refers to the outcomes, effects, and achievements that are attributable to the approach and deployment based upon the purposes addressed and implied in the Examination Items. The Examiners consider such aspects of the deployment as:

- The quality levels are demonstrated and supported by evidence
- The contributions of the outcomes and effects to quality improvement
- The rate of quality improvement
- The breadth of quality improvement
- The demonstration of sustained improvement
- The significance of improvements to the company's business
- The comparison with industry and world leaders
- The company's ability to show that improvements derive from their quality practices and actions

Examiners are trained to recognize companies that score at the 50% level of performance using these scoring guidelines. Their training calibrates this level and, through the consensus grading process, reinforces the appreciation for excellence which is demonstrated by performance beyond this level. A 50% performance means that a company has a sound, systematic, prevention based approach which includes on-going improvement with evidence of integration; the approach has been deployed to most major areas of the company; and positive result trends that are caused by the approach are demonstrated in major areas.



Lessons Learned from the Baldrige Award

Some of the lessons learned observed from the Baldrige Award are listed below using the Baldrige Categories to present them as a state of quality overview:

1.0 Leadership

- Senior management recognizes that quality is a strategic business issue.
- Executives are communicating a quality vision and an accompanying value system to their employees and building them into their company culture.
- The employment market for senior quality management positions indicates that the management structure of organizations are building an infrastructure to strategically deploy quality efforts.
- Senior executives are speaking out for quality in public forums throughout America.
- Senior management is not convinced of the relationship of quality performance driving financial performance -- financial measures, rather than quality measures and the need for long-term management, still drive their perception of company performance.
- Few senior managers use "management by fact" and apply the concept of process thinking to their own activities.
- Cross-functional involvement in quality planning is beginning to be seen as a necessary activity.

- Planning for quality improvement is delegated to lower levels of the organization than the top management team.

2.0 Information and Analysis

- Information technology and data bases exist in most companies.
- Benchmarking and sharing of information have increased greatly as a result of their emphasis in the Baldrige Criteria, however benchmarking is often confused with industrial tourism and few companies obtain the full value of this tool.
- Resources are required to implement long-term measurement systems for product quality monitoring and customer and employee satisfaction surveys. The economic environment has precluded some of these investments.
- Data collected are not distributed and communicated to all parties who require the processed information.

3.0 Strategic Quality Planning

- While benchmarking is becoming a more visible tool, few companies are integrating it with their strategic planning process.
- The "Six Sigma" stretch goal of Motorola has received great publicity and many companies are considering how to improve their goal-setting capabilities.
- Companies have poor communication methods to share their strategic goals and plans and, therefore, the organization is not in alignment with these goals.
- Measurement of the effectiveness of the company planning system is not a common quality management practice.

4.0 Human Resource Utilization

- Team activity has greatly increased and suggestion systems have been implemented to gain more input from employees, although participation tends to be low.
- While training budgets have increased substantially, the training tends to be basic and the effectiveness of training is not directly measured.
- Employee surveys are used to assess employee morale, however, first level management resists the empowerment of their employees, perceiving it as a risk to job security.
- While recognition has increased, recognition by presenting team quality improvement results to senior management is not greatly exercised.
- Quality of work life and the ergonomic design of working conditions are not integrated into quality programs.

5.0 Quality Assurance of Products and Services

- Manufacturing is a strong area for quality -- particularly for quality teams, statistical process control, just-in-time manufacturing, and supplier quality management.
- Companies are beginning to seriously use design of experiments, Taguchi methods, and quality function deployment to enhance their product design and development processes.

- The spectre of the ISO 9000 registration requirements of the European Economic Community has increased management's interest in basic quality assurance.
- While quality improvement is strong in manufacturing, corrective action tends to be symptomatic rather than focused on the root cause.
- New product development is an area for improvement for most companies -- especially the customer listening systems needed to align the product design and delivery system with the voice of the customer.
- Quality audits are not rigorously conducted in many manufacturing companies and are not conducted in service companies.
- Quality efforts tend to focus on manufacturing and fail to involve service, support, and business process areas.

6.0 Quality Results

- Quality levels are improving in many industries.
- Supplier quality programs, ISO 9000 and the Baldrige Award are all tending to improve the quality of the manufacturing supplier base.
- Many companies do not know which processes are their key business processes and therefore do not focus on their improvement.
- Product quality measurement is favored greatly over service quality measurement or customer-perceived quality performance.

7.0 Customer Satisfaction

- There is an increased focus on quick response to customers and formal complaint resolution, however management tends to be overdependent upon complaints as a source of customer feedback.
- People in support functions are just beginning to understand the concept of the "internal" customer.
- While customer contact people receive motivational training, they are not fully empowered to resolve issues and are reluctant to escalate the issue to the level of the individual with the authority to make the resolution.
- The process for integrating customer data with new product design and development is informal in most companies.
- Customer segmentation tends to be incomplete, not addressing all layers of customers (such as distribution channel or final consumer).
- While the use of customer surveys is increasing, there is little technical understanding of the appropriate application of survey results.
- Companies change their performance measurements frequently, producing a fragmented historical data base which is not able to make a comparison of trends over time.
- Companies tend to believe that replacement guarantees should satisfy the customer, rather than providing preventive action.
- Complaint systems are reactive and responding to formal complaints, rather than aggregating complaints from all sources and dealing with them as an integrated complaint management system.

Comparison of 1991 Quality and Productivity Award Criteria

There are five major quality awards that have been presented to American companies: the Deming Application Prize, the Malcolm Baldrige National Quality Award, the President's Award for Quality and Productivity Improvement, the NASA Excellence Award (George M. Lowe Trophy), and the Shingo Prize for Excellence in Manufacturing. This section of the study describes the particulars of each award and compares the various award criteria and scoring systems.

The Deming Application Prize

The Deming Prize was established in 1951 to honor the contributions of Dr. W. Edwards Deming to the quality control movement within Japan. The Deming Application Prize is awarded in three categories: Deming Application Prize for Division, Deming Application Prize for Small Business, and Quality Control Award for Factory. In addition, individuals who have uniquely contributed to Japan's body of knowledge about quality control and statistical methods may be awarded a Deming Prize. Any company that qualifies for the Deming Application Prize will receive it -- the prize is awarded without external competition and there is no maximum number of companies who may receive the award in a given year.

To qualify for the Deming Application Prize, top management must apply. This is called challenging the Deming Prize. The process to receive the award lasts three to five years and the company's management must convince the Deming Prize Committee that they are prepared for an on-site examination. These experts serve as examiners and audit the state of the quality system, paying particular attention to the use of statistical methods and using a brief set of "particulars" called the Deming Prize Application Checklist (Appendix A). To qualify for the award, a company must score 70 points or more, top management must score at least 70 points, and no unit of the company may score less than 50 points. Companies that have applied for the prize receive a report of the comments and recommendations of the Deming Prize Committee which contain the findings about the desirable and undesirable aspects of their quality operations and constructive suggestions for change.

The Malcolm Baldrige National Quality Award

The Malcolm Baldrige National Quality Award was established by President Ronald Reagan in 1987 to honor Malcolm Baldrige, the former Secretary of the Department of Commerce. The Baldrige Award has three categories for application: manufacturing, service, and small business. The Baldrige Award is competitive among the annual applicants and only two awards may be given in each category annually, however, the Board of Examiners may elect not to present an award in a particular category during a given year.

To qualify for the Baldrige Award, top management must apply. While the process to receive the award lasts one year from the time of application to the time of award announcement, it may take a company three to five years, or more, to develop a quality system that is competitive for the award. The application for the Award is limited to 75 single-sided pages for

the two large business categories and 50 pages for small businesses. To qualify for the Award, the applicant goes through an extensive process (see the above section on the Baldrige process). To be a contender for the award a company should be capable of scoring well above 700 points on the application. The highest score to date on the application has been in the mid-800 point range. However, the Baldrige Award is not granted solely on the competitive score. A more subjective assessment by the Judges is also made to evaluate the potential for the applicant to serve as a national role model for quality improvement. Each company that applies for the Baldrige Award will receive a feedback report that describes the findings of the Board of Examiners relative to the company's strengths and areas for improvement.

The President's Award for Quality and Productivity Improvement

The President's Award for Quality and Productivity Improvement was established by President George Bush in 1988 to recognize quality and productivity improvements among agencies of the Federal Government. An agency becomes eligible to apply for the President's Award if one or more Quality Improvement Prototypes (QIPs) have been selected from that agency. The Quality Improvement Prototype Award is given to smaller units within an agency that have made significant improvements in quality and productivity. The criteria for these Awards are contained in the Federal TQM Handbook (The President's Award is summarized in Appendix C). The criteria for the QIP Award are a sub-set of the President's Award Criteria. While the President's Award may be given to two agencies annually, QIP Awards may be given up to six governmental units.

To qualify for the Award top management must apply; however, unlike the Baldrige Award, applications are mailed to eligible agencies by the Federal Quality Institute. Like the Baldrige Award, the President's Award cycle is one year, however, this does not indicate the amount of time that it will take a government agency to become competitive for receiving the Award. The application for the Award is limited to 35 single-sided pages for agencies under 20,000 employees and 60 pages for larger agencies. To qualify for the Award, the applicant is evaluated by a Panel of Judges using the scoring guidelines for the Award. Only two President's Awards have been presented to date, so information about the competitive range is not available. The guidelines for the award indicate that scores in the range of 80 - 100% are considered to be World Class. As a measure of comparison 40-60% scores in the Award Criteria Categories indicate an organization with a sound, well-implemented program. Like the Baldrige Award, the score is not the sole determinant of the consideration for the President's Award. A more subjective assessment by the Judges is also made to evaluate the potential for the applicant to serve as a role model to government agencies for TQM implementation and quality improvement.

The NASA Excellence Award (George M. Lowe Trophy)

The NASA Excellence Award precedes the Baldrige Award by 3 years. It was initially established in 1984 by James Beggs, the Administrator of NASA, to honor those companies who have contributed to the success of the nation's aerospace efforts and to encourage superior quality and productivity in the aerospace industry. The NASA Excellence Award was renamed

the George M. Lowe Trophy in 1991 in memory of a 27-year NASA veteran and an early pioneer in the development of the NASA Space Programs. The Award is presented in two categories: large and small business. The Award is not competitive and may be given to as many applicants as demonstrate the level of excellence required over the period of time specified.

Top management must decide to apply for the Award and submits a letter of nomination with a brief statement of eligibility compliance. If selected by the Evaluation Committee to compete, the applicant then completes a 35 page application in response to the Award Criteria (summarized in Appendix D). The report guidelines requires that data covering a three year performance window be provided in the report. The Evaluation Committee reviews the applications and selects finalists to receive site visits. The Scoring Guidelines for the NASA Award are considerably different from the Baldrige and President's Awards. While the NASA Scoring Guidelines describe excellence as scores in the 91 - 100% range, the scores of Award recipients range between 800 and 900 points. All award applicants may request a debriefing to identify strengths and areas of improvement. Debriefings are conducted either face-to-face or by teleconference.

The Shingo Prize for Excellence in Manufacturing

The Shingo Prize for Excellence in Manufacturing was established in 1988 to honor Shigeo Shingo who, with Taiichi Ohno, was the co-creator of the revolutionary manufacturing techniques, methods, and processes which make up the Toyota Production System. This Prize recognizes companies and plants in the United States that have demonstrated outstanding achievements in manufacturing processes, quality, productivity enhancement, and customer satisfaction. The Shingo Prize is awarded in two categories for large and small businesses and only two awards may be given in each category. In addition, individuals who conduct professional research (whether in industry, academia or consulting) in the field of manufacturing excellence may submit a paper for consideration in a competition for a Shingo Research Prize. The Research Prize has three categories: professional, graduate students, and undergraduate students. Up to three awards may be given annually in each category.

To qualify for the Shingo Prize, top management must apply. The Shingo Prize follows the same examination process as the Baldrige Award. The first stage of the award is the evaluation of the written application to the Prize Achievement Criteria (Appendix E). The Board of Examiners makes their award recommendations following their site visits to the finalists to the Shingo Prize Council. The decisions of the Prize Council are final. Companies that have applied for the Prize receive a report citing notable accomplishments and opportunities for possible improvement within their manufacturing systems.

Comparison of Award Criteria

These five awards have similarities in the way that they recognize improvement in company performance in the areas of quality and productivity. All of these awards recognize

the need for management attention (Baldrige Criteria 1,0), teamwork and empowerment (Baldrige Criteria 4.0), and quality assurance (Baldrige Criteria 5.0), which produce results. The

NASA Award and the Shingo Prize do not specifically address information and analysis (Baldrige Category 2.0) or strategic quality planning (Baldrige Category 3.0). The Deming Prize Application Checklist does not specifically address customer satisfaction (Baldrige

Comparison of Quality Award Evaluation Criteria

Categories	Deming Prize	MBNQA	President's Award	NASA Award	Shingo Prize
Leadership	1, 2 ○	1 +	1 +	2.1 ○	IA +
Information & Analysis	4 ○	2 +	6 ○		
Strategic Qualtiy Planning	10 ○	3 +	2 +		
Human Resource Utilization	3 ○	4 +	4,5 +	2.2 +	IB +
Quality Assurance of Products and Services	5,6,7,8 +	5 ○	7 ○	1.2 ○	IC, II +
Quality Results	9 +	6 ○	8 ○	1.3 ○	IIIA,B +
Customer Satisfaction		7 +	3 +	1.1 ○	IIIC +

Numbers identify categories in respective awards. o = Area for Improvement. + = Adequately Covered.

Category 7.0). One interesting observation from this study is that the Shingo Prize, with only slight changes could apply equally well to a service company.[15]

The above table references each of the various award criteria to the seven Baldrige Award Criteria and provides an assessment of the strength of the criteria for that category. Note that the most complete award, relative to the Baldrige, is the President's Award. This is not surprizing since the President's Award was developed following the Baldrige Award. The Shingo Prize achievement criteria are strong relative to the Baldrige Award, but they are not as complete. The NASA Excellence Award Criteria are not as complete nor as robust as the Baldrige Criteria, with the exception of the human resources area (section 2.2 in the NASA Criteria). The Deming Prize particulars are stronger than the Baldrige in Categories 5.0 and 6.0, but not as complete in all of the other areas. All of the Baldrige Categories are addressed by the Deming Prize particulars except for Category 7.0 (Customer Satisfaction). Section 5.0 was judged as weak in the Baldrige since it does not have a strong focus on cycle time and waste reduction. (Companies that pursue ISO 9000 certification or integrate ISO 9000 with the Baldrige Criteria will eliminate this perceived area for improvement.) Section six was judged as

Comparison of Category Weighting

		Deming Prize	MBNQA	President's Award	NASA Award	Shingo Prize
Scoring Basis		Prescriptive	Non-Prescriptive	Non-Prescriptive	Non-Prescriptive	Non-Prescriptive
Criteria Definition Stability		Fixed	Continuously Improving	Continuously Improving	Continuously Improving	Continuously Improving
Point Maximum		100	1000	200	1000	100%
Categories Weighted		NO	YES	YES	YES	YES
Weighting Relative Category	1	200	100	100	220	100
	2	100	70	75	0	0
	3	100	60	75	0	0
	4	100	150	150	180	100
	5	400	140	150	250	500
	6	100	180	250	120	200
	7	0	300	250	230	100

weak in the Baldrige since it does not provide a strong assessment of business results. (Note that this area was changed significantly in the 1992 Baldrige Award Criteria.)

Comparison of Category Weighting

The quality system of a quality award should exhibit the characteristics of both customer satisfaction and continuous improvement. Customer satisfaction means that the applicants for the Award feel that they have been accurately and fairly judged and that the assessment provides them with value in terms of increased self-knowledge of their quality system's strengths and areas for improvement. Continuous improvement means that interpretation of the criteria changes and scores achieved from year to year are difficult to compare. Scoring an application is probably the most emotional aspect of the assessment process. The first aspect of scoring is the weighting of the categories. The Table above shows an assessment of the various Award systems and their approach to weighting their categories after using the categories normalized to the Baldrige Criteria from the previous section.

Note that the Deming Prize is the only award that is prescriptive and has a fixed criteria definition. The Deming categories are not formally weighted, however, many areas of the company are graded and the entire grade sheet is used in each area. The purpose of each award is reflected in the way that the categories are weighted. Most notably, see the Shingo Prize where applicants can score a maximum of 500 points in a single category -- manufacturing improvement, likewise the Deming Prize gives 400 points in process control while the Baldrige

gives 300 in customer satisfaction. The weighting of the categories is used to reflect the behavior desired in the successful applicants.

Comparison of Award Scoring Systems

Interestingly, neither the Deming Application Prize nor the Shingo Prize have a formal scoring system. The Baldrige Scoring system was described earlier. A matrix is included in the Application Guidelines to show how the Examiners are to assign scores to particular items depending on the approach/deployment/results for that particular Examination Item. The scoring systems for the President's Award is so specific in its definitions of behaviors, that it borders on a prescriptive approach. The NASA scoring guidelines are skewed to the high side since 71-80% of the points in a category can be obtained by "gradual continual improvement." The NASA Award is unique in that it uses a specified duration for the system being in place, percent of deployment, resource allocation levels for quality program, and the degree of planning integration as indicators of the scoring. The NASA Award is the most complicated of the scoring systems and appears to be an area for improvement.

Analysis of Alternative Approaches to Internal Assessment

The 23 companies studied in this analysis could be grouped into four categories based on their approach to the administration of the assessment criteria. These categories include: self-assessment only, self-assessment plus MBNQA assessment, MBNQA assessment, and custom internal assessment program. These categories and their ratings are shown below:

1. Self - Assessment: 5
 This class of company used a survey or set of forms to conduct their internal Baldrige assessment.

2. Self - Assessment plus MBNQA Assessment: 1
 This company uses the self assessment to screen divisions before they apply for an internal award.

3. MBNQA Criteria Used for Internal Assessment: 9
 These companies followed the Baldrige Examination Process and used the Baldrige Criteria.

4. Companies developed customized approach: 8
 These companies adapted the MBNQA Criteria to their company's culture. These companies included: Control Data Corporation, Hewlett Packard, IBM Europe, Intel, Proctor & Gamble, Westinghouse, Whirlpool, and Xerox.

Although two of the standard MBNQA-clone company awards offered multiple award levels (e.g., bronze, silver, and gold), there was not much originality in the MBNQA look-alike awards. The unique applications for internal assessment are found in the custom category. Each of the unique items in these assessment programs will be described under the "best practice"

area. First, a brief note on "best practice." In the case of internal assessment, it only goes back about 8 years, Westinghouse having the earliest internal assessment program. Other than a few of the "quality regulars" there has been little in-depth revision of the Baldrige Criteria. Since this is the case, there is too little data to call a practice best. So, they will be considered as interesting processes or, at least different approaches. In addition, the single company that combined self-assessment with MBNQA evaluation approach will be discussed.

Best Practices and Unusual Observations

- Company A: This company used a self-assessment survey by all of the divisions as a screening mechanism to determine finalists for their internal award program. Then they asked these finalists to prepare an application and go through an MBNQA process to compete for the company-wide award.
- Company B: This company does not use the Baldrige Criteria at all, but uses two radar diagrams to display their management and product quality profiles. On the management profile they have eight dimensions: Planning, recognition, participation, trust, cooperation, environmental, people management, and acceptance of new ideas. On the product profile they have six dimensions: price, service, reliability, functionality, user friendliness, and documentation. These reviews are conducted by a cross-functional management team.
- Company C: This company customized the Baldrige Categories to their own cultural norms to define world-wide excellence: substituting fact-based management for information and analysis; strategic planning for strategic quality planning; COMPANYNAME people for human resource utilization; quality of processes and products for quality assurance of products and services; and measurement & results for quality results. Both leadership and customer satisfaction labels stayed the same. The areas to address under each of these seven areas was then defined in terms of the company's programs and culture. Otherwise, this company followed the MBNQA process.
- Company D: This company translated the seven Baldrige Categories into five categories which they call the five areas of quality management: planning process, customer focus, improvement cycle, process management, and total participation. Each of these different categories was uniquely defined for the company's quality program and culture. The MBNQA scoring system was used for the evaluation; and results were displayed using a radar diagram with these five categories comprising an operating unit's quality profile.
- Company E: This company merged the MBNQA Criteria with ISO 9000 and their own long-standing "reliability essentials" program to create a composite set of evaluation criteria.
- Company F: This company uses a twelve category evaluation criteria, called the conditions for excellence, for their internal assessment process: customer orientation, participation, development, motivation, products and services, processes and procedures, information, suppliers, culture, planning, communications, and accountability. The company has also changed the weighting system for the categories and uses a unique scoring system. Another twist this company puts on the Baldrige process is the use of

- external examiners and judges for their assessors. Otherwise, their method follows the Baldrige process.
- Company G: This company uses the Baldrige process to determine eligibility for their internal company award. After a division has scored 500 points on the written first stage application, then they are eligible for a site visit where they are evaluated on the six dimensions of the company's values: results orientation, risk taking, discipline, customer satisfaction, quality, and a great place to work. The administrative processes follow the Baldrige Award.
- Company H: This company has not decided to start an award process, but has challenged each operating unit to use the Baldrige Criteria to achieve a "Baldrige certification" which occurs when they score over 750 points as verified by a one day site visit from a team of examiners. This challenge is not too burdensome from the paperwork viewpoint since the site visit is principally oral. This company has basically used a Deming scoring system with the Baldrige Criteria.
- Company I: This company imposed a twenty page limit on applicants and applies a unique award criteria that is tied to their operational definition of TQM. Eligibility for the award includes business units, divisions, teams, and individuals. Three questions are evaluated in the application: why was the problem chosen; how was the problem approached; and what results were obtained and how significant were there. Each of these three questions is scored according to the contribution of: innovation, leadership; product, and service.

Biggest Area for Improvement

The biggest problem area outstanding is the scoring habits of the examiners. In one company's training of internal examiners they found point spreads in scoring to be greater than four hundred points, which implies that the examiners needed more training to calibrate their observation skills.

"I would lay it down as a basic principle of human organization that the individuals who hold the reins of power in any enterprise cannot trust themselves to be adequately self-critical. For those in power the danger of self-deception is very great, the danger of failing to see the problems or refusing to see them is ever-present. And the only protection is to create an atmosphere in which anyone can speak up."

John W. Gardner
How to Prevent Organizational Dry Rot
Harper's Magazine
October 1965

Produced by the staff of the International Benchmarking Clearinghouse in conjunction with the APQC Consulting Group. This paper was edited by Gregory H. Watson, Vice President of Benchmarking Services at APQC. Mr. Watson served as a member of the 1991 Board of Examiners for the Malcolm Baldrige National Quality Award.

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DEFINING THE PERFORMANCE GAP: CONDUCTING A SELF-ASSESSMENT

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PREFACE

This paper presents two different approaches to performing self-assessments of continuous improvement activities. Case Study 1 describes the activities performed by JSC to assess the implementation of continuous improvement efforts at the NASA Center. The JSC approach included surveys administered to randomly selected NASA personnel and personal interviews with NASA and contractor management personnel. Case Study 2 describes the continuous improvement survey performed by the JSC Safety, Reliability, and Quality Assurance (SR&QA organization). This survey consisted of a short questionnaire (50 questions) administered to all NASA and contractor SR&QA personnel. The questionnaire is based on the eight categories of the President's Award for Quality and Productivity Improvement. It is designed to objectively determine placement on the TQ benchmark and identify a roadmap for improvement.

INTRODUCTION

We have been following Continuous Improvement (CI) principles at JSC for many years, although only in the last several years have we recognized our efforts as part of a CI program. Of course, the degree of implementation varied from organization to organization and we had never measured how well we were doing within individual organizations or, for that matter, Center-wide. After conducting management retreats and consulting with outside sources, we decided that an internal self-assessment of our progress would help us baseline our efforts to date. The self-assessment survey would provide a benchmark placement based on the President's Award criteria; point out the strengths and weaknesses in our CI implementation; allow development of action plans to focus on areas for improvement; and help identify communication problems.

JSC conducted a Center-wide survey in 1991 and established a benchmark based on the President's Award criteria. The same survey was conducted in May, 1992 and other measurement techniques were added to supplement this survey. The entire survey in 1992 consisted of several different data gathering tools including the Center-wide survey administered to 325 employees; personal interviews with 100% of our top executives; organizational questionnaires focusing on specific CI accomplishments; and surveys of managerial employees at four major contractors concerning the impact of JSC's CI efforts on the contractor community.

While these Center-wide activities were taking place, the JSC SR&QA organization initiated their own independent self-assessment activities. This consisted of a CI survey conducted in June 1992 that was administered to all SR&QA personnel (NASA and contractor). Actual

participation in the survey was about 90% (A total of 633 respondents out of about 700 personnel). As with the JSC Center-wide survey, this survey also provided a benchmark based on the President's Award criteria. Loral Space Information Systems, the main JSC SR&QA contractor, had previously developed a benchmark in 1991 using the same criteria. However, only high level contractor managers were used to establish that benchmark.

With these two independent and simultaneous CI survey activities, we learned a great deal about ourselves and how effective we have been in establishing, communicating, and implementing our CI goals and objectives.

CASE STUDY 1 - JSC SELF-ASSESSMENT

BACKGROUND

Historically, the JSC efforts had focused on R&D productivity initiatives and the Team Excellence program. In the Fall of 1989, we conducted the first self-assessment of our quality environment. We did this prior to applying for OMB's Quality Improvement Prototype Award; and indeed, we did receive this award in 1990. Shortly after this self-assessment was conducted, a number of our organizations (particularly Engineering and SR&QA) became extremely interested in quality improvement. Managers started reading publications and attending seminars on Total Quality (TQ), which we are now beginning to refer to as Continuous Improvement (CI). In July of 1990, 150 JSC managers attended a W. Edwards Deming seminar held in Houston and jointly sponsored by JSC and Loral, our SR&QA support contractor. This was the first exposure to CI for many of our managers and it helped us realize that we needed a formal CI program at JSC.

In the Summer of 1990, we formed an ad hoc committee composed of JSC managers to determine the strategy to set up and implement a CI program. The committee members decided that the program should start at the top level of management, so they initiated CI training for themselves as a first step. After evaluating several potential consultants and vendors, they selected The Cumberland Group to help us develop an implementation plan, establish a CI benchmark and structure, and provide the first phase of CI training. Cumberland conducted the first employee CI survey in February 1991 and also conducted executive interviews. A month later, we held a 2-day retreat for our senior executives and their deputies. At the retreat, the executives became aware of and committed to a CI philosophy and approach; updated the JSC vision, mission, goals, and objectives; chartered the Executive Council which includes all direct reports to the Center Director; and determined our benchmark placement based on the President's Award criteria.

In April 1991, the JSC TQ Steering Committee, which is composed of the Deputy Directors from all JSC organizations, was formed and became the `shepherds' of our Center-wide CI implementation in developing our overall policy and strategy. We also established subcommittees to oversee the implementation of CI training and strategic planning, and the formation of process improvement teams. By June 1991, we had started the formal implementation of our CI initiative. This included two day training sessions, taught by The Cumberland group, for all managers and supervisors; training of future in-house facilitators; training in analyzing work processes and in the use of TQ tools; and training of Q+ Team personnel. Our Q+ Teams (we have one team per directorate or program office) are CI initiative partners with management. They are responsible for establishing systems to implement CI activities in their organizations and for helping our employees become more

knowledgeable about and involved in our improvement efforts. With our Q+ Teams trained and in place, our managers trained, and our facilitators identified, we were ready to move forward with our CI efforts.

DEVELOPMENT AND ADMINISTRATION OF DATA GATHERING TOOLS

About one year into the JSC CI initiative (April-May 1992), we conducted a self-assessment of the state of the Center in preparation for a two day retreat for the Steering Committee and our Q+ Team Chairs. The goal was to assess the direction that JSC should take in CI activities for the next year. As mentioned in the Introduction, five data gathering tools were used to perform the self-assessment:

1) A 107 question quality survey keyed to the President's Award criteria was administered to 325 randomly selected Civil Service employees. This was basically the same survey administered to 125 employees in early 1991, although 15 new questions focusing on strategic planning, goal setting, and empowerment were added.

2) This same quality questionnaire was administered to our 15 Q+ Team Chairs. These employees were considered more knowledgeable than most employees about our CI activities because of their involvement in planning and implementing CI programs for their organizations.

3) The top 18 members of the JSC senior staff were interviewed to determine their involvement in and their plans for CI, and their view of the progress we have made to date in CI. The interviews consisted of 14 open ended questions specifically prepared by JSC for these executive interviews.

4) Each of the Q+ Teams completed a JSC-designed questionnaire on CI accomplishments in their organization. The questionnaire focused on education, improvement opportunity identification, continuous improvement implementation, and measurement.

5) We also surveyed managers at four major contractors to gain their input into JSC's CI objectives, barriers, actions, and plans as they relate to the contractor community.

The data gathered from these five tools were first analyzed on a Center-wide basis. Later, individual organization results were available to each Directorate/Program Office for their own analysis and action planning.

ANALYSIS OF FINDINGS

To analyze the results of the self-assessment, we formed five JSC subcommittees with members from the JSC TQ Steering Committee and the Q+ Team Chairs. The subcommittees and their areas of concentration were 1) Strategic Planning; 2) Leadership, Empowerment, and Training; 3) Process Improvement; 4) Measurement and Benchmarking; and 5) Customer/Supplier Partnerships. Each subcommittee had access to all five data sources in analyzing JSC's performance in the eight categories of the President's Award. The analysis performed by each subcommittee included:

1) Correlation of survey questions with the executive interview data.

2) Analysis of Center-wide responses versus responses from Q+ Chairs.

3) Analysis of statistically significant differences between 1991 and 1992 data.

4) Analysis of implications of highest and lowest ranked questions.

5) Identification of strengths and weaknesses in each Award category.

6) In-depth review of elements at each level in the President's Award criteria against JSC's accomplishments to date.

7) Benchmark placements and rationale for the placement.

8) After-the-fact comparison with the 1991 benchmark placements which were established solely by JSC Senior Staff at their March 1991 retreat. Except for Training and Strategic Planning (which were the two major areas of Center-wide focus during our initial deployment of TQ in 1991-1992), all the 1992 benchmark placements were lower than those assigned in 1991.

RESULTS OF SURVEYS AND INTERVIEWS

The Steering Committee and the Q+ Chairs held a retreat in June 1992 to discuss the results of their analysis of the survey data. Each subcommittee presented the strengths and weaknesses and the benchmark rating for their assigned areas of concentration. They also recommended three objectives for the next year based on the identified strengths and weaknesses. This retreat resulted in a common understanding of the future CI direction for JSC and identified specific objectives and action plans to focus our CI activities for the next year. Additionally, we formed a separate training advisory subcommittee to continue our emphasis in this critical area.

Following the June retreat, the Steering Committee met with the Executive Council in July 1992 to finalize the 1992-1993 objectives and actions and to establish priorities. This meeting was designed to get the `buy-in' of the top tier of JSC executives and to ensure that the Executive Council was willing to commit the time and resources needed to achieve the objectives. We felt the meeting was very successful and provided the opportunity for the Executive Council (the `Owners') and the Steering Committee (the `Implementors') to discuss and then finalize our CI direction for the coming year.

NEXT STEPS

We plan to conduct a comparable self-assessment annually. The quality questionnaire will be reviewed to determine if additions or modifications are required. We also plan to incorporate CI questions in the next NASA-wide Culture Survey. Using these survey techniques and any new methods that we develop, we will determine our benchmark placements annually and assess the effects of our improvement efforts. In the interim, the subcommittees that we established will work to accomplish the objectives and actions that were adopted. Individual organizations will also analyze their own survey data to assess their TQ implementation efforts and to establish their own objectives and action plans.

CASE STUDY 2 - SR&QA SELF-ASSESSMENT

BACKGROUND

In conjunction with the Center-wide CI activities, the JSC SR&QA organization initiated our own CI program. At first, many of these activities were focused on the Loral (contractor) side. We established a Loral TQ Steering Committee in 1990 to guide our efforts. Following this, we formed process improvement teams that were primarily composed of contractor personnel. Strategic goals were set and teams were established to define objectives for these goals. We conducted an internal culture survey and also identified teamwork inhibitors via a survey that did include NASA SR&QA personnel. All personnel were briefed on the results of the culture survey and the teamwork inhibitor survey.

In 1991, NASA and Loral joined together to form a joint SR&QA TQ Steering Committee. The Deming seminar was conducted in the spring of 1991. Through a series of retreats, we developed integrated NASA and Loral goals. In the summer of 1991, we established our first TQ benchmark placement, based on the President's Award criteria, using inputs from Loral management personnel only. Our process improvement team activities continued, but more NASA personnel were assigned to the teams. Our training department began training in the use of TQ tools, facilitator skills, and team building for all SR&QA personnel.

By late 1991 to early 1992, we had conducted strategic planning seminars where we defined our Mission, Goals, and Values; our improvement objectives were defined; and teamwork between NASA and Loral was really emphasized by management. Loral and NASA employees were beginning to work as teammates in their day-to-day activities as well as on the teams to which they were assigned. We thought the time had arrived to perform an internal self-assessment of the progress we had made in our CI activities

DEVELOPMENT AND ADMINISTRATION OF DATA GATHERING TOOLS

We decided to continue to use the President's Award criteria for our self-assessment benchmark because we had a previous benchmark using this criteria and the JSC survey was also using this criteria. Thus, this would provide several benchmark comparisons. The American Productivity and Quality Center (APQC) prepared the initial questionnaire for the survey. We changed some of the wording of the questions and added/deleted some questions to tailor the questionnaire to our employees needs. The final questionnaire consisted of 50 questions, 10 of which were designed to obtain demographic data. In addition to the demographic questions and the specific questions, we developed codes for each organization to allow sorting by organization and to assure anonymity for the employees. The remaining 40 questions were keyed to the eight categories of the President's Award criteria with five questions per category. These categories are represented by the bars designated as A through H on the SR&QA benchmark Chart (See Figure 1, SR&QA Continuous Improvement Benchmark) and are defined as:

A) Management Leadership & Support
B) Strategic Planning
C) Customer Satidfaction
D) Employee Training & Recognition
E) Employee Empowerment and Teamwork
F) Continuous Improvement Measurement and Analysis
G) Continuous Improvement Activities
H) Quality Productivity Improvement Results

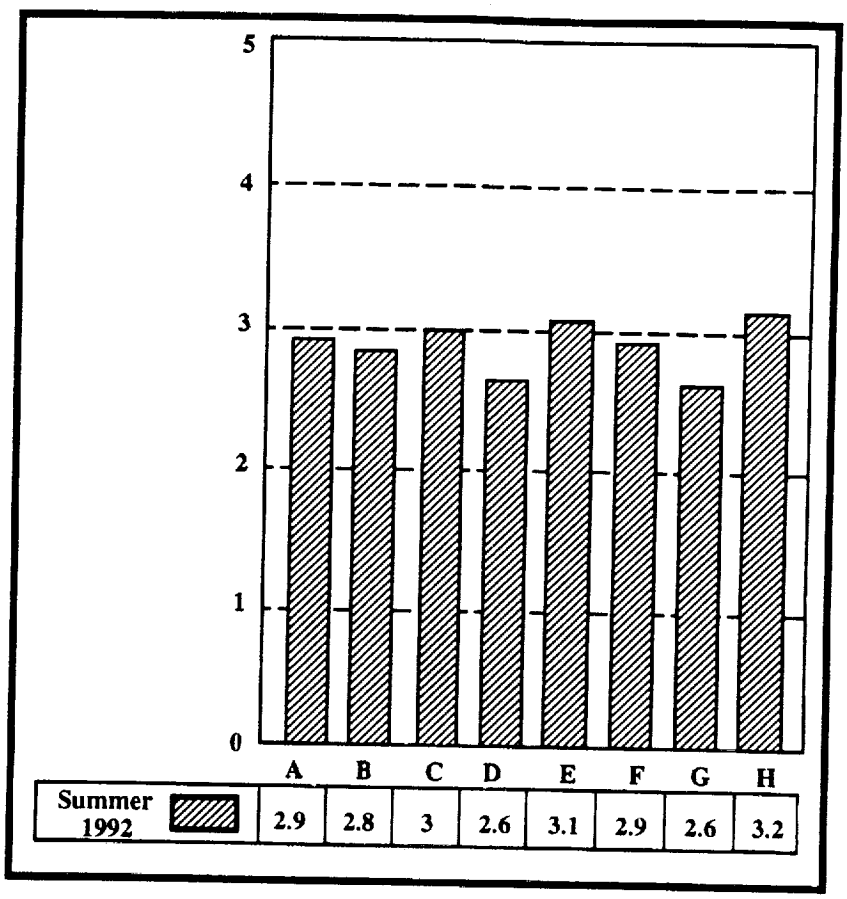


FIGURE 1 - SR&QA Continuous Improvement Benchmark

The self-assessment survey had three basic purposes: 1) Provide an objective means for determining our placement on the benchmark chart, 2) Provide a roadmap for identifying areas that need improvement at the working group level, and 3) Provide a baseline for measuring the effectiveness of our improvement efforts. Each group of five questions for the eight categories was designed to objectively determine our placement with respect to the five status levels of the President's Award criteria. In addition, each individual question was carefully designed to measure different aspects of each category. For example, the aspects of Category A (Management Leadership & Support) are goal-setting, top-down communication, bottom-up communication, evaluation, and recognition. Individual questions in Category A address each of the aspects. We had decided that the survey would be provided to **all** SR&QA employees rather than a randomly sampling of employees. This included NASA (at JSC, White Sands Test Facility, and Downey/Huntington Beach), and contractor employees from Loral (the main SR&QA contractor), SIMCO (who operates the SR&QA calibration laboratory), and Webb-Murray & Associates (who are responsible JSC industrial safety, test safety, and the Safety Learning Center). We realized that a special plan was required to assure that a large percentage of employees participated in the survey. So, on a published schedule basis, we provided NASA and contractor focal points in the building where the employees worked to solicit their responses. Electronic scan sheets and the survey questionnaire were available in these locations and the employees were encouraged to come into the room to complete the survey. We briefed them on the value of the survey to them and to the SR&QA organization

and assured their anonymity. No names were required on the response sheets, groups with less than five employees would not be provided separate reports, and management was not allowed to see individual responses. This approach resulted in an overwhelming response: with slightly over 700 employees, we received 633 responses to the survey.

While we were planning the collection of survey data, we contracted with the University of Houston Clear Lake (UHCL) to develop the database and reporting system for our survey data. The President's Award criteria is scored from 1 to 5 points. After discussion with APQC and UHCL, we decided to use a scoring scale of 1 to 10 (1 representing inadequate implementation; 10 representing excellent implementation). These scores were then converted to the 1 to 5 scale. This would allow a larger range of responses and provide more granularity in our survey results.

ANALYSIS OF FINDINGS

We completed the survey and received our reports in July 1992 from the UHCL. Individual reports were prepared and distributed for about 55 organizations. Other reports were developed by `rolling up' individual reports into the next higher level of management. Each report included a bar graph summarizing the average response for each survey category as well as detailed data on the responses to each of the five questions in each category. The responses to the 10 demographic questions were summarized only at the top management level for NASA and each of the individual contractors.

As mentioned previously, the objectives for this self-assessment survey were to determine our placement on the benchmark and, more importantly, to identify areas for improvement at the lowest possible working group level. The first objective was realized with the average benchmark scores from the survey (See Figure 1). The second objective was reached by carefully analyzing the survey data to identify areas for improvement, develop action plans, and implement actions. The joint SR&QA TQ Steering Committee was responsible for identifying the top level tasks that required improvement actions (such as benchmarking improvements) and for assuring integration of lower level activities. Each organization reviewed their own survey data, discussed the results with their employees, and developed action plans to initiate improvements in their work area. These improvement ideas were shared with their management and with other organizations.

RESULTS OF SURVEY

For the overall SR&QA organization, the benchmark placements for each category ranged from 2.6 to 3.2 as can be seen in Figure 1. These scores were rather consistent from organization to organization. The lowest scores were in category D (Training and Recognition) and category G (Continuous Improvement Activities). Analysis of the responses to individual questions revealed that the deficiencies in category D were in measuring the effectiveness of our training program and in providing timely recognition of individuals and teams. Actions are being taken to develop training plans tailored for each employee. These individualized plans will address the needs of each employee in skills training, personal development training, and CI training. Currently, training effectiveness is determined through course evaluations that are completed immediately following the course. During the coming year, we will be implementing follow-up evaluations three to six months after each course. Through this method, we can determine the actual impact each course has had in improving performance. We have established a unified recognition program that includes NASA and contractor personnel. The timeliness of the presentation of recognition awards has been greatly increased.

The low score in category G was attributed to the lack of documentation and measurement of key work processes. A number of these processes have been documented, but they have not been made readily available to most employees. In many cases, process measurements have not been established. Our process improvement teams are making progress in documenting the processes and are beginning to establish meaningful measurements. Training courses on individual work processes are also being provided for employees. We have also identified a need for benchmarking studies in significant SR&QA processes. A pilot study has already been initiated; more studies will follow.

In addition to these actions, individual work groups are continuing to identify areas for improvement at the working level and are developing action plans to improve those areas. The SR&QA TQ Steering Committee is coordinating these efforts and provides a forum for sharing the `lessons learned ' by each work group. The Committee also is responsible for developing action plans for certain tasks that must be work at the top level of management.

NEXT STEPS

The self-assessment survey will be administered to all SR&QA employees every six months for about two years. We will review the survey questionnaire and may modify individual questions based on this review. However, we will not make drastic changes in the questionnaire because we want to maintain a valid relationship to our established baseline. As new benchmark data is obtained, we will assess the effects of our CI improvement activities on the benchmark. Benchmark charts mounted on large boards have been placed in the primary buildings where NASA and contractor personnel are housed. The current benchmark placements are plotted on these charts and subsequent placements will also be plotted. This is a positive way of showing the employees that their participation in the self-assessment survey is important and to make them aware of the progress that has taken place in our CI efforts.

The value of this type of survey will probably decrease after about two years. So we will investigate new methods for assessing our CI performance. The first method that we are considering is the use of certified internal auditors to determine our benchmark placement.

CONCLUSIONS

Although JSC and the JSC SR&QA organization are using slightly different methods for performing self-assessments, we are accomplishing a common goal: measuring our CI performance so that we can focus our resources on critical areas for improvement. Self-assessment using employee inputs is a quick, simple, and effective way of obtaining that measurement early in the CI initiative.

Omit To
PA2.0

CLOSING THE "GAP": USING NASA'S QUALITY AND EXCELLENCE AWARD CRITERIA AS A SELF-EVALUATION TOOL

PANEL A1 - USING AWARD CRITERIA TO IMPROVE ORGANIZATIONAL EFFECTIVENESS

Brenda England
Manager, Engineering Process Improvement
Hamilton Standard Division
United Technologies Corporation
October 20-21, 1992

OBJECTIVES

- Provide a practical roadmap on how to use NASA's Quality and Excellence Award as a self-evaluation tool
- Illustrate how the self-evaluation process fits as an integral part of a Total Quality Management (TQM) strategy

AGENDA

- What is a "Gap"?
- Identifying Gaps
- Closing Gaps
- Self-Evaluation as part of a TQM strategy
- Caveats & Benefits
- Appendix Review

WHAT IS A "GAP"?

A difference between what NASA would like to see* and what we see in our business today.

* = *As indicated by NASA's Quality and Excellence Award Application Criteria*

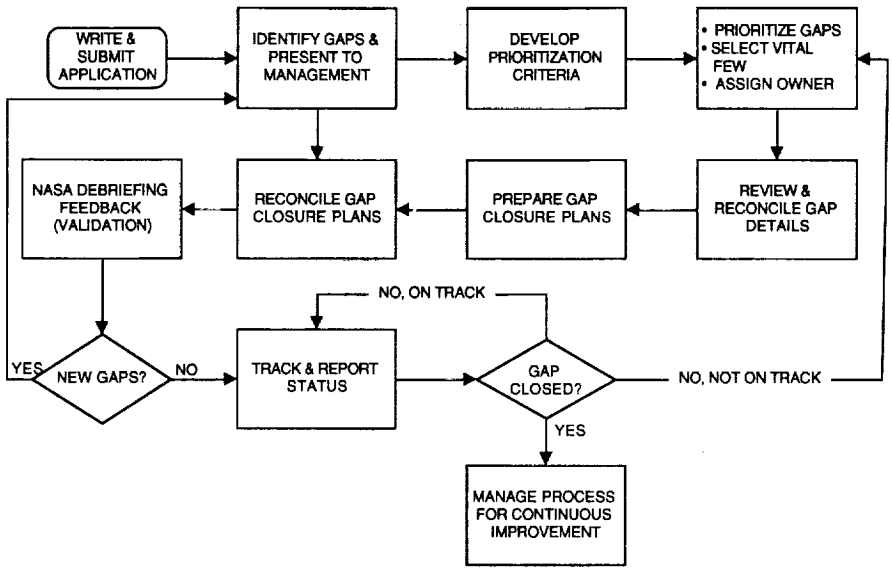
IDENTIFYING GAPS

- Who: NASA Application Report Team
 - Formed with Gap concept in mind
 - Senior Management - Buy In
 - Major Process Representatives - Find/Communicate Gaps
- When: Immediately after the Application Report is in the mail

CLOSING GAPS: ROLES & RESPONSIBILITIES

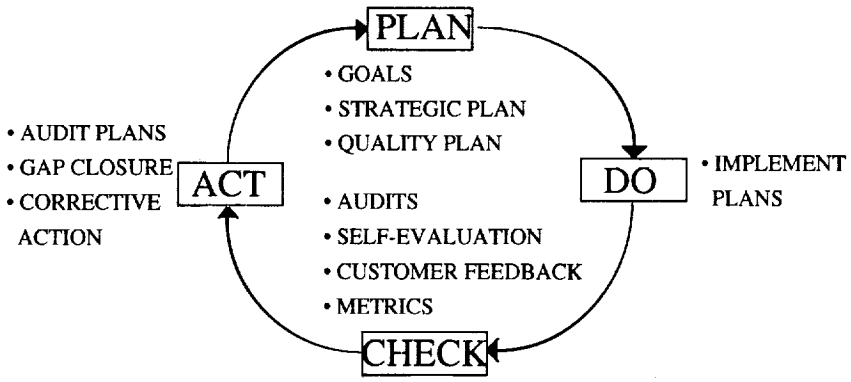
- Application Report Team: Identify Gaps
- Senior Management Team: Prioritize & select gaps to close
- Gap Owner: Representative from senior management team responsible for gap closure plan development & implementation
- Application Report Team Leader: Manage the Process, Provide Tracking and Closure

NASA CRITERIA GAP CLOSURE PROCESS



SELF EVALUATION

PART OF A TQM SYSTEM



CAVEATS & BENEFITS

- Caveats
 - Not a prescription to run your business
 - Gaps may not identify root causes
 - Avoid "Analysis Paralysis"
 - Pet issues are not Gaps

CAVEATS & BENEFITS (CONT.)

- Benefits
 - Methodical approach to improvement
 - Produces a documented trail of improvement
 - Better understanding of NASA criteria
 - Management (Gap Closure)
 - Department (Communication)
 - Results are starting to appear
 - Baseline to track improvement

APPENDIX CONTENTS

- FORMS
- EXAMPLE GAP DESCRIPTION
- EXAMPLE GAP CLOSURE PLAN
- ANNOTATED PROCESS DESCRIPTION

GAP DESCRIPTION SHEET

Prepared By:_____ **Date:**_____

Gap Identification

Business Impact: H M L Cost: H M L Gap ID No.: _____
Short Description of Gap from Application Team: _____

What NASA Would Like to See

Guidelines Reference: _____ Supplement Reference: _____
Guidelines Criterion: _____

Supplement Information: _____

What We See in Place Today in S&SS

Items Covered in Application Report: _____

Other Things We Did Not Write About: _____

Full Description of Gap:

OMIT TO
P.A2.1-6

"The Few Key Measures"

John H. Bitzer
Director, SR&QA
Civil Space & Communications
Martin Marietta Astronautics Group

An important element of our TQM/CI process is the measurement of change. While numerous actions are taking place within the organization as the result of tactical plans, investments, attitudes and growth, the affects on the bottom lines may not be apparent to everyone. Our "Few Key Measures" is a method that evolved to assess and communicate results of our continuous improvement efforts.

The "Few Key Measures" is intended to supply information on overall organization process. In summing or integrating the plans and results from various operating levels, traceability to specific changes must be maintained.

The method for accumulating, evaluating and presenting information for the "Few Key Measures" needed to satisfy a variety of internal customer interests. The desirable features considered in our method included:

- A group consensus that the measurements and the criteria for assessment were creditable and meaningful;
- Subjective data be minimized and objective data traceable;
- Bench marking against other corporate organization and competitors be utilized;
- External customer feedback used to the maximum;
- Goals and progress to be highly visible to the organization.

The format for the "Few Key Measures" evolved from these desires and is shown in Figure 1. The horizontal bar with a performance range of below average to superior is used for bench marking, goal setting, progress measurement and quick-look statusing. The performance criteria for each level within the range to superior varies with the particular areas of interest. We selected six areas that I will discuss later. A legend box for results lists pertinent information of a positive or negative nature that relates to the area of interest or the performance criteria. Entries in this legend box are the "bottom line" impacts.

Reference to the tactical improvement initiatives is included to provide traceability to our Annual Performance Improvement Plan.

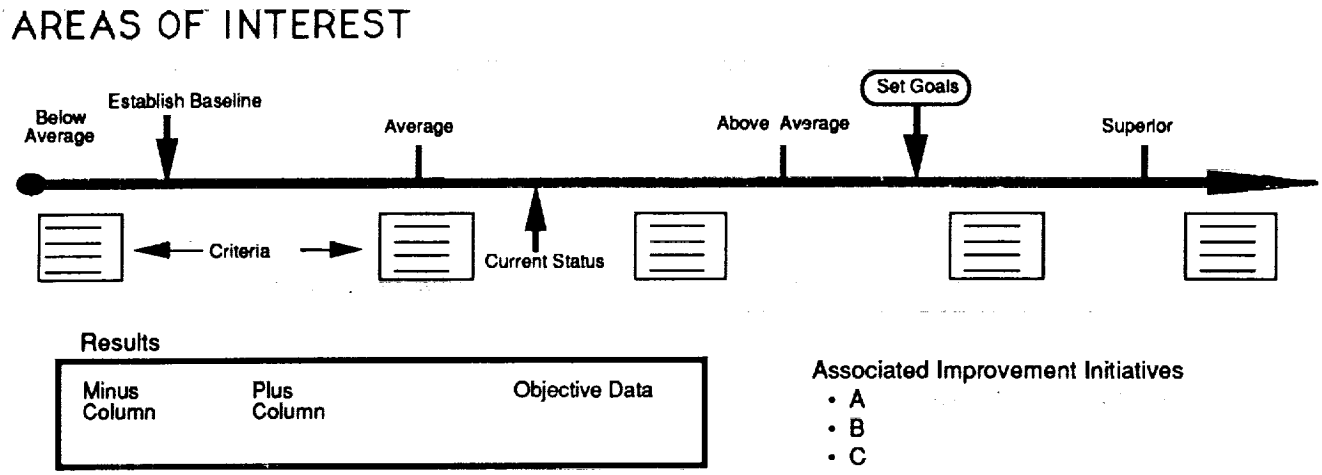


Figure 1

The areas of interest for top level performance indicators are probably very similar for all organizations supplying products or services to the aerospace industry. We settled on:

Customer Satisfaction
Product Quality
Cost Performance
Schedule Performance
TQM Training
Organizational Growth
Profitability

Customer Satisfaction, Figure 2, relies heavily on feedback from internal and external customers. The idea is, of course, feedback from the external customer. Award fee evaluations offer the best opportunity for bottom-line determination of customer satisfaction. An 80% threshold for award fees was chosen as average since 80% is the accepted norm in the George M. Low trophy evaluation. Self-evaluations on program performance are also good indicators for customer satisfaction. Program assessments that produce ratings such as red, yellow, green can be included. Communications with the customer, although less objective in terms of quantifying levels of satisfaction, are good indicators and should be included. Certainly special recognition, such as a Low finalist or recipient can also be used. The benefits of this measure are obvious, strengths and weaknesses with different customers on different projects are highlighted and action plans, where appropriate, can be initiated. There is a very strong relationship between customer satisfaction and the areas of Product Quality, Cost Performance and Schedule Performance. Redundancy in reporting results should be avoided whenever possible.

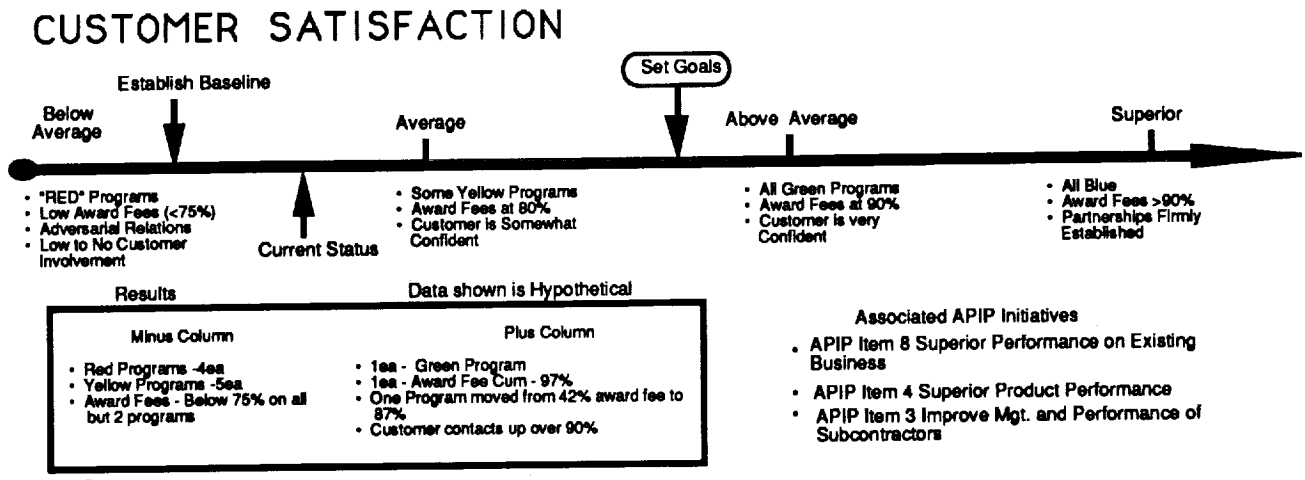


Figure 2

Product Quality, Figure 3, combines the many aspects of product quality. The relationship of the lost value to total product costs, the cost of problem prevention and detection, the thought-put of the manufacturing process and design quality are our elements of measure. Please note that mission success is a non-negotiable result.

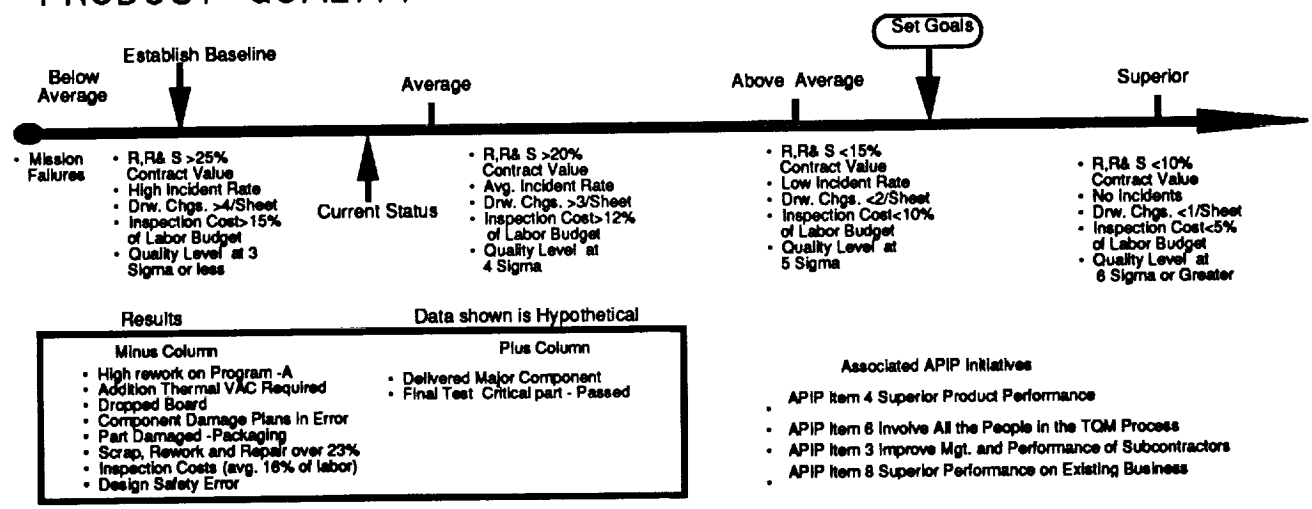


Figure 3

TQM Teaming, Figure 4, the social aspects of the TQM/CI process are very complex. The desire to establish partnership with customers and suppliers is a major change in the "contract" culture. Employee involvement through teaming, ownership and commitment seeks new levels of in the work ethic. The transition of management styles from autocratic to participative is a major change. Objective measures for these characteristics are difficult, our current level of sophistication causes reliance on subjective indicators.

Employee surveys, the training investment, employer suggestion program participation, use of teams in design and production areas, customer and supplier involvement in day-to-day operations and problem solving are effective measures.

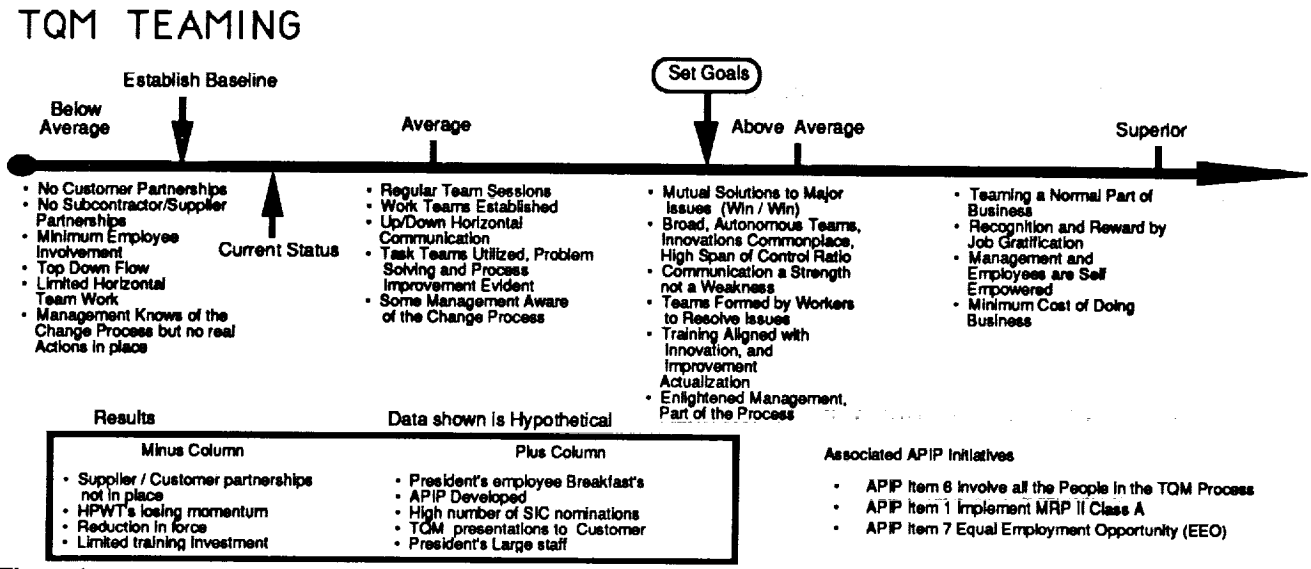


Figure 4

Cost Performance, Figure 5, summarizes estimated and actual cost for each of the operating budgets. Highly objective, this measure deals with quantifiable results. Goals, progress, and problem areas are easily identified. The cost benefits of TQM/CI are also incorporated, real cost savings returned to the budget source is the bottom line measure.

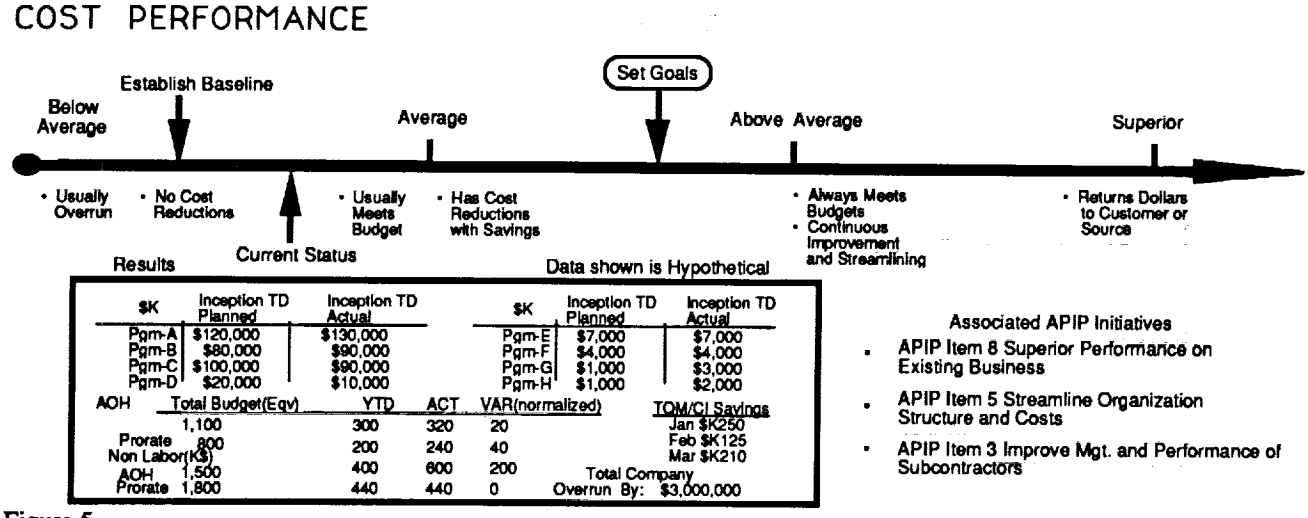
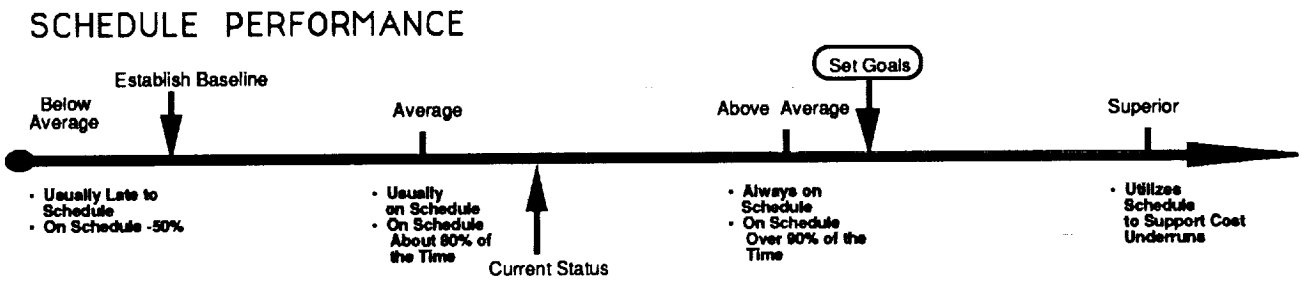


Figure 5

Schedule Performance, Figure 6, similar in nature to the objective results of cost performance at the company level compares planned and actual completion of contractual milestones.



Results — Data shown is Hypothetical

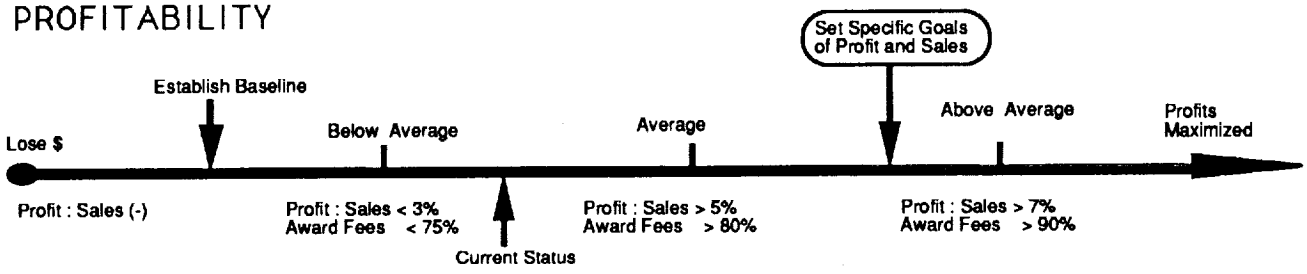
Program	Milestones Cum through 1990	Milestones Planned/Actual (1991)
Pgm-A	Red	8/4 50% (Red)
Pgm-B	Yellow	10/5 50% (Red)
Pgm-C	Green	6/0 0% (Red)
Pgm-D	Red	9/3 33% (Red)
Total Company	Red	33/12 36% (Red)

Associated APIP Initiatives

- **APIP Item 8 Superior Performance on Existing Business**
- **APIP Item 5 Streamline Organization Structure and Costs**
- **APIP Item 3 Improve Mgt. and Performance of Subcontractors**
- **APIP Item 2 Establish Concurrent Engineering Techniques**

Figure 6

Profitability, Figure 7, the business benefit of the company is profit. We have chosen to use profit to sales ratio and the dollar-weighted results of award fees. Achievement scaling is based on commitment to our corporate office and in turn our stockholders.



Results — Data shown is Hypothetical

$K	Year End LROP	Projected Year End	Current Ytd LROP	Current Ytd Actual
Sales	$200,000	$150,000	$50,000	$50,000
Orders:	$800,000	$600,000	$200,000	$200,000
Profit:	$6,000	$4,500	$2,000	$2,500
Profit to Sales Ratio:	3%	3%	4%	5%

Associated APIP Initiatives

- APIP Item 8 Superior Performance on Existing Business
- APIP Item 5 Streamline Organization Structure and Costs
- APIP Item 1 Implement MRP II Class A
- APIP Item 4 Superior Product Performance

Figure 7

Organizational Growth, Figure 8, is based on compounded growth in annual sales dollars. The "Few Key Measures" presents only current year progress, most organizations, including ours, have at least a five-year plan in business strategy. In today's environment, compounded annual growth goals may be unachievable; performance against sales projections could be more realistic.

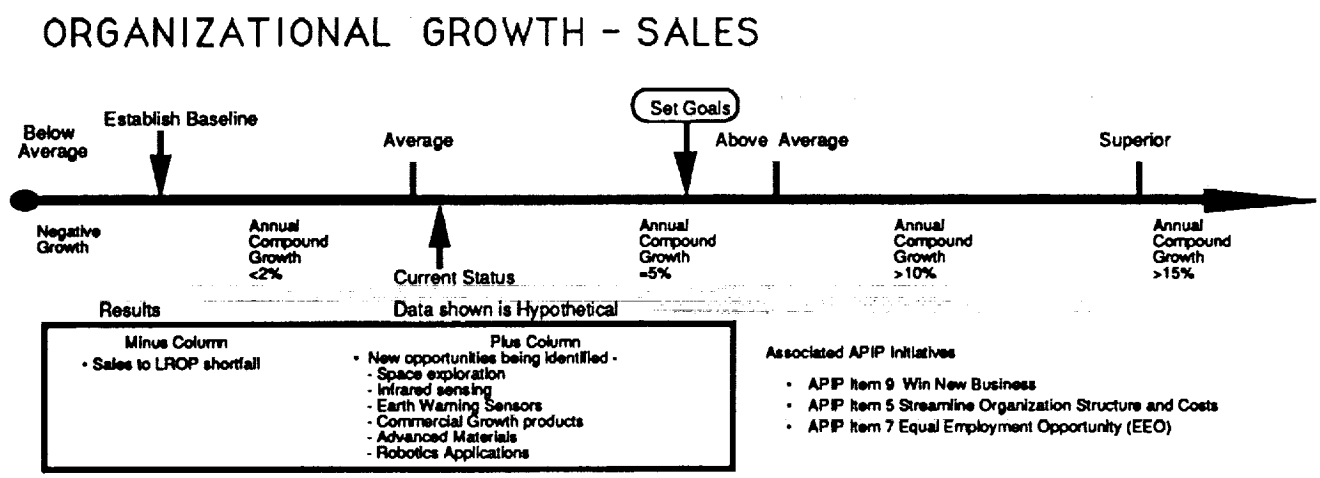


Figure 8

The "Few Key Measures" has become a valuable tool in assessing our overall organization performance, the affect of changes and investments we have made, and in confirming that TQM/CI benefits the organization.

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WHAT'S THE BOTTOM LINE PAYBACK FOR TQM?

Brian Usilaner, Senior Vice President for Quality
Sirota & Alper Associates Inc.

INTRODUCTION

With increasing competition, U.S. corporations have been forced to make major changes in the way they operate, and many organizations have implemented improvement strategies based on the philosophy and principles of Total Quality Management (TQM).

While TQM's popularity has increased over the past decade to become the "in" management philosophy, very little research has been done to determine whether organizations implementing TQM efforts have improved their performance and competitive position in the marketplace. This lack of evidence about the benefits of implementing an organization improvement strategy based on TQM principles is a critical gap in what is known about TQM. Another major gap in knowledge about TQM is how various organizations have implemented diverse TQM strategies and integrated these efforts into existing organization cultures, systems and processes.

What is TQM? TQM seeks to improve product or service quality and increase customer satisfaction by systematically evaluating an organization's culture, systems and processes and continuously making improvements. TQM is a positive organization improvement strategy which involves the following: (1) a focus on systemic rather than individual causes of poor quality, (2) the use of statistical evidence as the basis for quality improvement actions and for the assessment of their impact, (3) an emphasis on intra- and inter-departmental communication in solving and preventing problems, and (4) removal of defects through process improvement rather than inspection.

What differentiates TQM from other organization improvement strategies? We believe that TQM, or what we'd rather call Total Management, differs from past organization improvement strategies in two ways. First, TQM is a much broader organization management philosophy than other past improvement approaches such as management-by-objectives, quality of work life, or employee involvement. TQM encompasses all organization functions and disciplines and for the first time provides an operational framework that aligns these functions and disciplines toward the same goals--continuously improving customer service and quality. Second, a national standard or set of criteria has been established for TQM, the Malcolm Baldrige National Quality Award, and this Award provides organizations with a path they can follow to design, implement and evaluate their TQM strategies.

PURPOSE OF ARTICLE

The purpose of this article is to explore in detail TQM's impact on improving organization performance and how effective TQM strategies are designed and implemented. Both of these issues will be addressed primarily by a discussion of a recent study of TQM efforts conducted by the U.S. General Accounting Office (GAO), with Brian Usilaner as project leader.[1] A number of other studies will also be used to expand upon the GAO data.

GAO STUDY

The GAO study examines the impact of formal TQM improvement strategies on the performance of selected U.S. companies. The study grew out of a concern by a number of U.S. Congressmen that little is known about the impact of various quality-related efforts many companies have adopted to remain viable and profitable in an increasingly competitive world marketplace. Specifically, the study addresses: (1) what has been the performance impact of adopting TQM improvement strategies, (2) how has improved quality been achieved, and (3) what lessons may be applicable to U.S. companies in general.

Companies Participating in GAO's Study

Corning, Inc., Telecommunications Products Division, Corning, NY
Digital Equipment Corporation, Maynard, MA
Eastman Kodak Company, Eastman Chemicals Division, Kingsport, TN
Ford Motor Company, North American Auto Division, Dearborn, MI
General Motors Corp., Allison Transmission Division, Indianapolis, IN
General Motors Corp., Cadillac Motor Car Division, Detroit, MI
Globe Metallurgical, Inc., Beverly, OH
Goodyear Tire and Rubber Company, Akron, OH
GTE Corp., Telephone Operations, Irving, TX
Hoechst Celanese Corp., Chemical Group, Dallas, TX
International Business Machines Corp., Rochester, MN
International Business Machines Corp, Endicott, NY
L.L. Bean, Inc., Freeport, ME
Milliken & Co., Spartanburg, SC
Motorola, Inc., Schaumburg, IL
Paul Revere Insurance Group, Worchester, MA
Seagate Technology, Small Disk Division, Oklahoma City, OK
Timken Company, Bearing Division, Canton, OH
USAA Insurance Company, Property and Casualty Div., San Antonio, TX
Westinghouse Electric Corp., Commercial Nuclear Fuel Div., Pittsburgh, PA
Westinghouse Electric Corp., Westinghouse Furniture Sys., Grand Rapids, MI
Xerox Corp., Business Products and Services, Fairport, NY

Study Approach/Methodology

GAO conducted its study between June 1990 and February 1991. GAO first interviewed experts from industry, professional and trade associations, universities, and government agencies to develop its study methodology. GAO also conducted a comprehensive review of the literature on quality and analyzed existing studies that relate to TQM. Based on this analysis, GAO decided to use the Malcolm Baldrige National Quality Award criteria as the basis for defining quality and determining whether a company had implemented a well-designed TQM strategy. Once this was decided, GAO put together a list of companies that had scored highest on the written portion of the Baldrige examination since the Award's inception in 1988.

Basically, the approach to the study was to measure whether the companies identified by the Baldrige evaluation had improved their performance since implementing TQM improvement strategies. Additionally, the study examined how improved quality was achieved and what lessons might be applicable to U.S. companies in general.

While GAO understood that this approach had its methodological shortcomings, it decided that this approach was best given the relatively short amount of time allocated for the study.

To determine the impact of TQM strategies on corporate performance, GAO analyzed empirical data in four broad categories:

(1) employee relations,
(2) operating procedures,
(3) customer satisfaction,
(4) financial performance.

The first three data categories are required by the Baldrige application. The fourth was added since it gets at the fundamental question about TQM's impact on economic performance which was asked by Congress when requesting the study.

GAO identified 22 companies that had received Baldrige site visits during 1988 and 1989 and contacted these companies to request participation in the study. Twenty companies agreed to be part of the study after it was agreed that any data which could be identified with a particular company was to remain confidential--only aggregate data would be published.

Companies shared data with GAO to varying degrees. Many companies provided detailed data on their quality efforts and the four measures of performance while others provided data more in summary form. To ensure that the data GAO analyzed was reliable, study staff visited each company to validate the data. Only data that were verifiable--where an audit trail existed--were analyzed by GAO. Therefore, the number of companies on which a particular analysis was performed was often less than the universe of 20.

Existing Studies on TQM

Five studies were identified by GAO that relate to the question about whether implementing a TQM effort improves a company's performance. These studies are:

* JUSE Study of Deming Prize Winners[2]
* PIMS (Strategic Planning Institute) Research[3]
* Conference Board Survey of TQM Efforts in U.S. Companies[4]
* ASQC Quality Study[5]
* University of Michigan Study on Corporate Culture[6]

Each study points to the fact that organization improvement strategies encompassing many of the elements of quality can lead to substantial improvements in performance. The methodologies used by these studies are very different, and some are more scientifically rigorous than others, but together they lend support to the premise that the GAO study attempted to test: whether well-designed and implemented quality improvement strategies have a positive impact on company performance.

Summary of GAO Study Results

As noted, GAO gathered and analyzed data on four measurable areas that could demonstrate the impact of TQM strategies on company performance. These areas were employee relations, operating procedures, customer satisfaction, and financial performance.

Overall, the data from the 20 companies studied suggest that TQM strategies, if properly designed and implemented, can significantly improve company performance on the four factors measured. The degree of performance impact among four factors varies, but undeniably points in a very positive direction. For example, the companies studied had an average annual improvement in market share of 13.7 percent, had an 11.6 percent drop in customer complaints, recorded a 12 percent reduction in order-processing time, and measured a 10.3 percent decline in defects.

RESULTS IN DETAIL

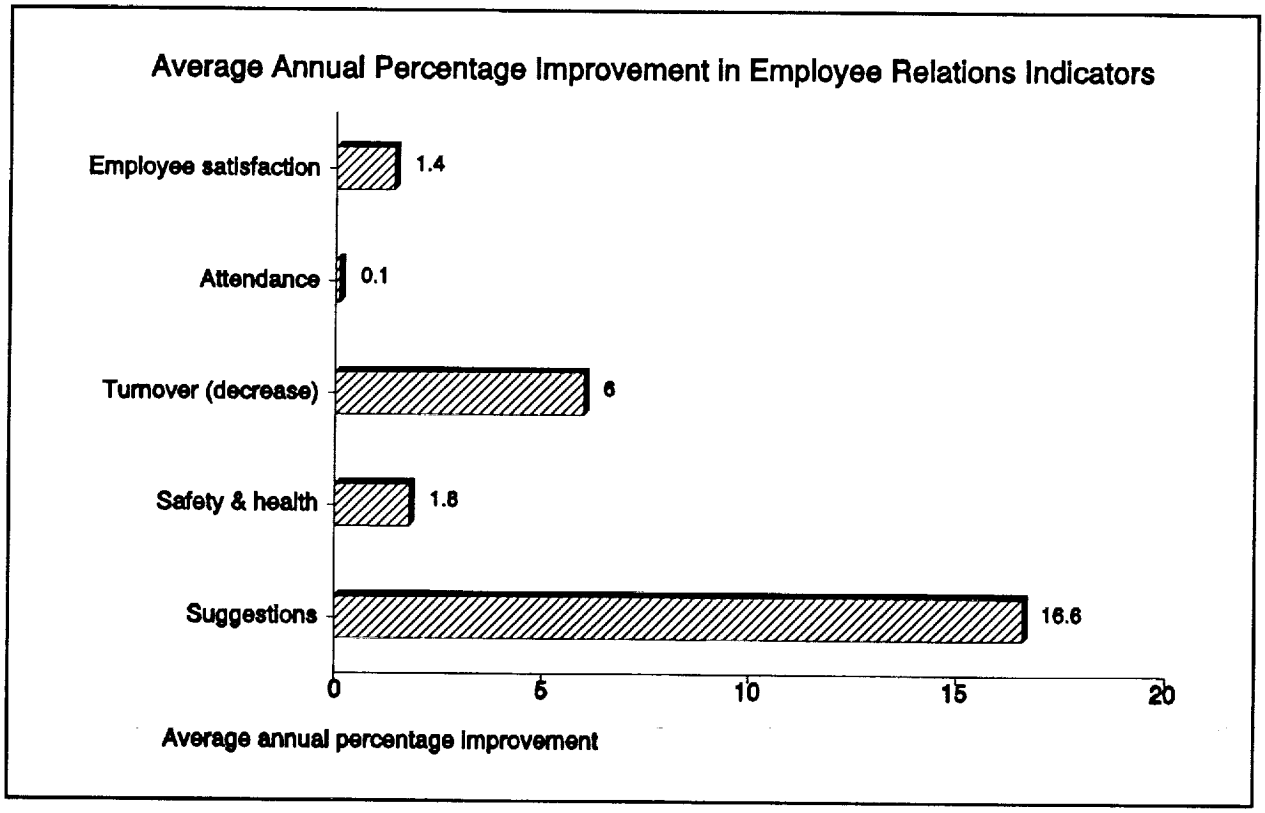
Employee Relations

As identified by the Baldrige criteria, a very important TQM element is employee involvement in all aspects of a quality effort. Improvements in employee morale and satisfaction are indicators of whether employees are fully involved in a company's TQM efforts, as are other employee relations indicators such as attendance, turnover, safety/health, and effectiveness of an employee suggestion system. As the following table indicates, many of the companies providing reliable data show improvements in all employee relations indicators of performance. While turnover and safety/health indicators displayed the least improvement, these indicators were above industry average at the study companies. *Figure 1.1* provides a graph of the specific employee relations results achieved by companies expressed as an annual rate of improvement.

Table 2.1: Employee Relations Indicators

Performance indicator	Number of responding companies	Direction of indicator: Positive (favorable)	Direction of indicator: Negative (unfavorable)	Direction of indicator: No change
Employee satisfaction	9	8	1	0
Attendance	11	8	0	3
Turnover	11	7	3	1
Safety/health	14	11	3	0
Suggestions received	7	5	2	0
Total	**18**	**39**	**9**	**4**

Figure 1.1: Average Annual Percentage Improvement in Employee Relations Indicators



One other employee relations indicator, training, was investigated, but GAO did not publish this data in its report because it had difficulty auditing the data. However, some of the training data is worth noting. First, training activity increased in 18 of the 20 companies studied. Second, training as a percent of employee time ranged from 1.8% to 4.2%, and specific quality training averaged 28 hours per year. And third, expenditures on employee training ranged from .7% to 5% of sales and averaged 2.7%.

Operating Procedures

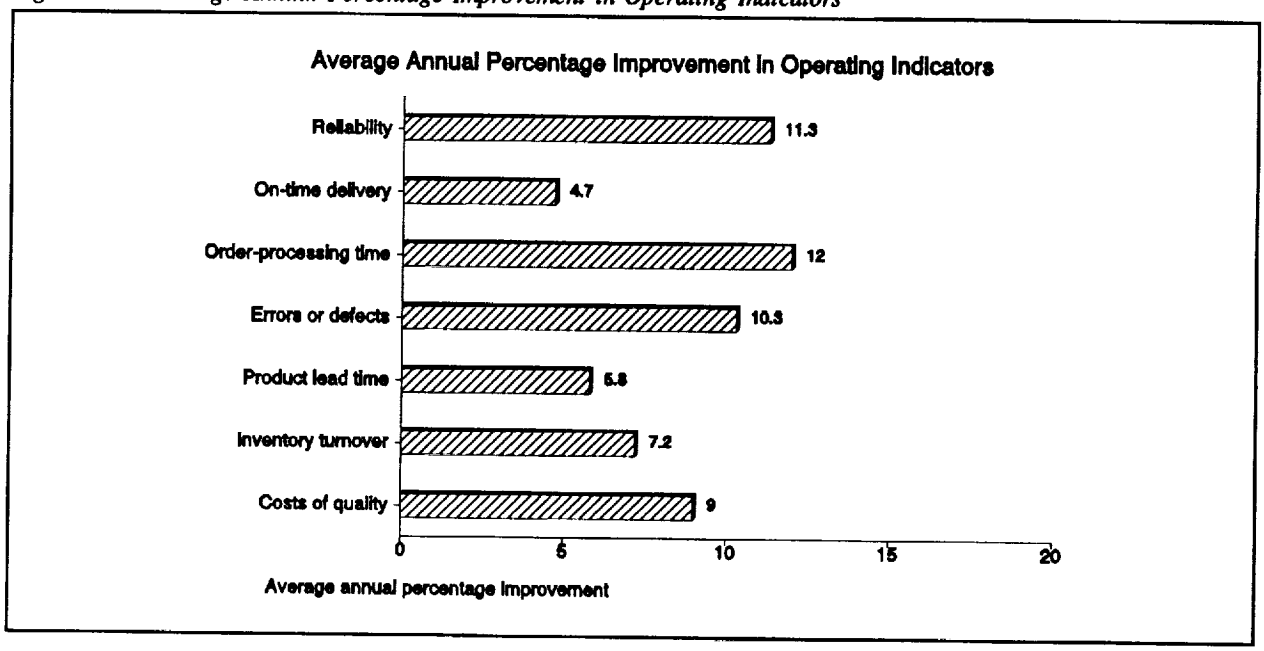
Indicators of the effectiveness of operating procedures measure the quality and cost of a company's products and services. These indicators are: (1) reliability, (2) timeliness of delivery, (3) order processing time, (4) production errors, (5) product lead time, (6) inventory turnover, (7) quality costs, and (8) cost savings. All twenty companies provided data on their operations and each stressed the importance of analyzing time-related measures which are indicators of customer responsiveness. A few companies have developed a "cost of quality" indicator, however, most lack this capability in their accounting systems.

Over ninety percent of the studied companies report positive improvements in all the operating indicators listed above. These data are summarized in *Table 3.1*. *Figure 2.1* provides a graph of the average annual percentage improvement in operating indicators.

Table 3.1: Operating Indicators

		Direction of indicator		
Performance indicator	**Number of responding companies**	**Positive (favorable)**	**Negative (unfavorable)**	**No change**
Reliability	12	12	0	0
Timeliness of delivery	9	8	1	0
Order-processing time	6	6	0	0
Errors or defects	8	7	0	1
Product lead time	7	6	0	1
Inventory turnover	9	6	1	2
Costs of quality	5	5	0	0
Cost savings	9	9	0	0
Total	**20**	**59**	**2**	**4**

Figure 2.1: Average Annual Percentage Improvement in Operating Indicators



Customer Satisfaction

Customer satisfaction is a key element of TQM. The definition of customer satisfaction has evolved greatly during the past decade from one of meeting the minimal requirements of customers to one of attempting to surpass customer requirements. Product and service quality is now defined by the customer, instead of the company, and today companies spend significant resources both measuring customer needs, requirements and expectations and continuously trying to exceed their customer's wishes.

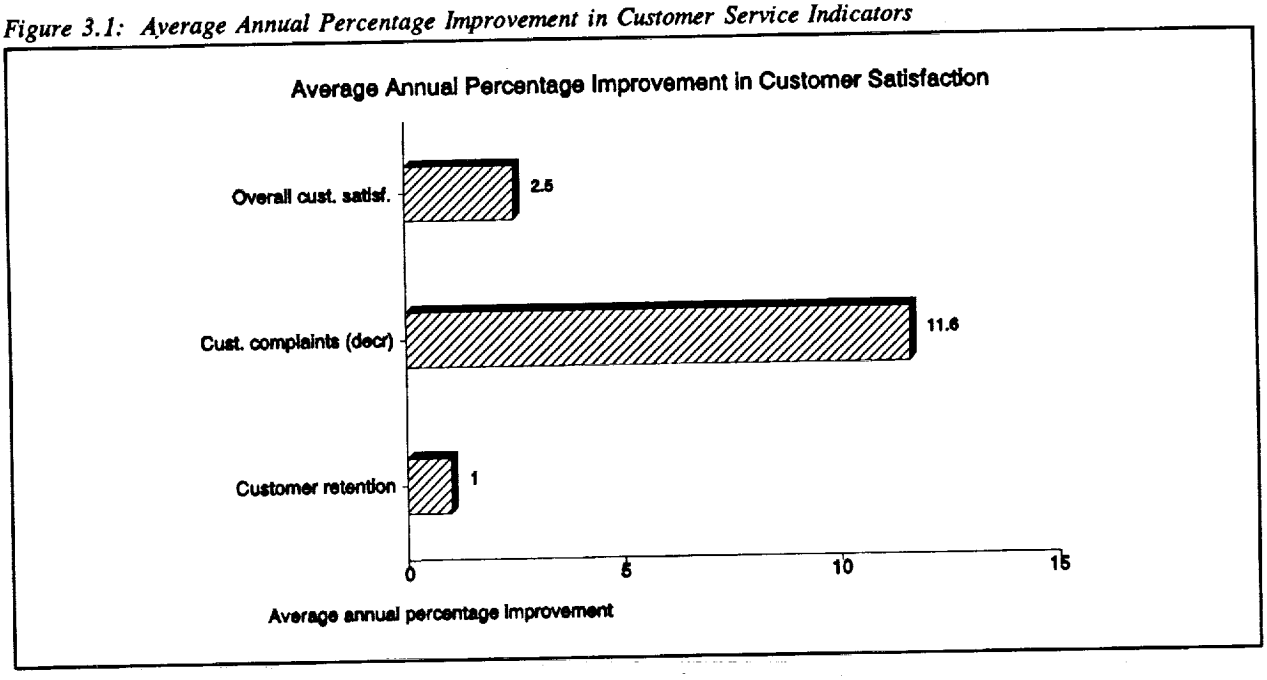
Customer satisfaction in the GAO study was measured by (1) overall satisfaction, (2) customer complaints, and (3) customer retention.

Overall customer satisfaction increased for 12 of the 14 reporting companies. Customer complaints declined in 5 of 6 reporting companies. Customer retention improved in 4 of 10 reporting companies, remained unchanged at 4 companies, and slightly decreased at 2 companies.

Table 4.1: Customer Service Indicators

Performance indicator	Number of responding companies	Direction of indicator: Positive (favorable)	Direction of indicator: Negative (unfavorable)	Direction of indicator: No change
Overall customer satisfaction	14	12	0	2
Customer complaints	6	5	1	0
Customer retention	10	4	2	4
Total	**17**	**21**	**3**	**6**

Figure 3.1: Average Annual Percentage Improvement in Customer Service Indicators



Financial Performance Indicators

Improved financial performance is at the heart of all TQM efforts. The degree to which companies believe there is a strong relationship between implementing TQM strategies and improvements in financial performance usually determines the seriousness of and resources spent on TQM efforts.

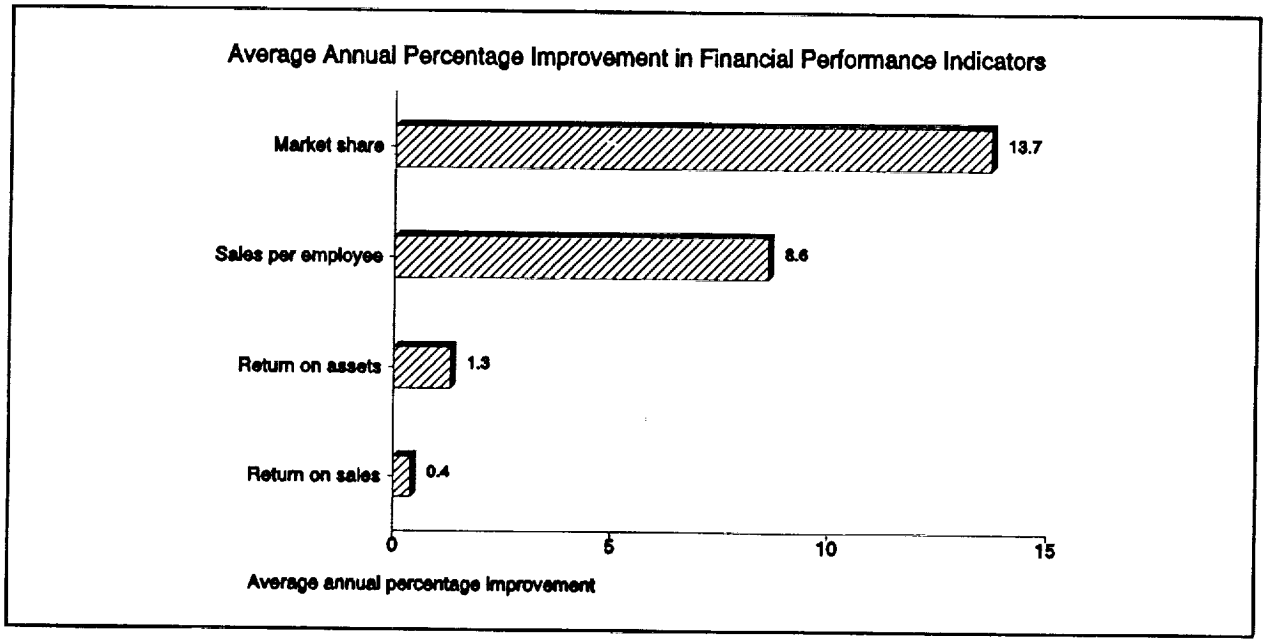
The indicators used by GAO to measure financial performance improvement were: (1) market share, (2) sales per employee, (3) return on assets, and (4) return on sales. As *Table 5.1* shows, financial performance significantly improved for all indicators. Sales per employee was the most positive indicator, with the others having almost an equal positive performance direction.

The two companies that reported an unfavorable direction in performance cited increased foreign competition for this decline. But these two companies claimed that their negative direction in performance was ameliorated by their TQM efforts. Obviously, financial indicators of performance are subject to a wide range of external factors such as the general condition of the economy and supply and demand conditions in a particular industry. However, financial ratios increased for 13 out of the 15 companies with accurate data, providing support for a positive relationship between implementing TQM strategies and improved economic performance.

Table 5.1: Financial Performance Indicators

		Direction of indicator		
Performance indicator	**Number of responding companies**	**Positive (favorable)**	**Negative (unfavorable)**	**No change**
Market share	11	9	2	0
Sales per employee	12	12	0	0
Return on assets	9	7	2	0
Return on sales	8	6	2	0
Total	**15**	**34**	**6**	**0**

Figure 4.1: Average Annual Percentage Improvement in Financial Performance Indicators

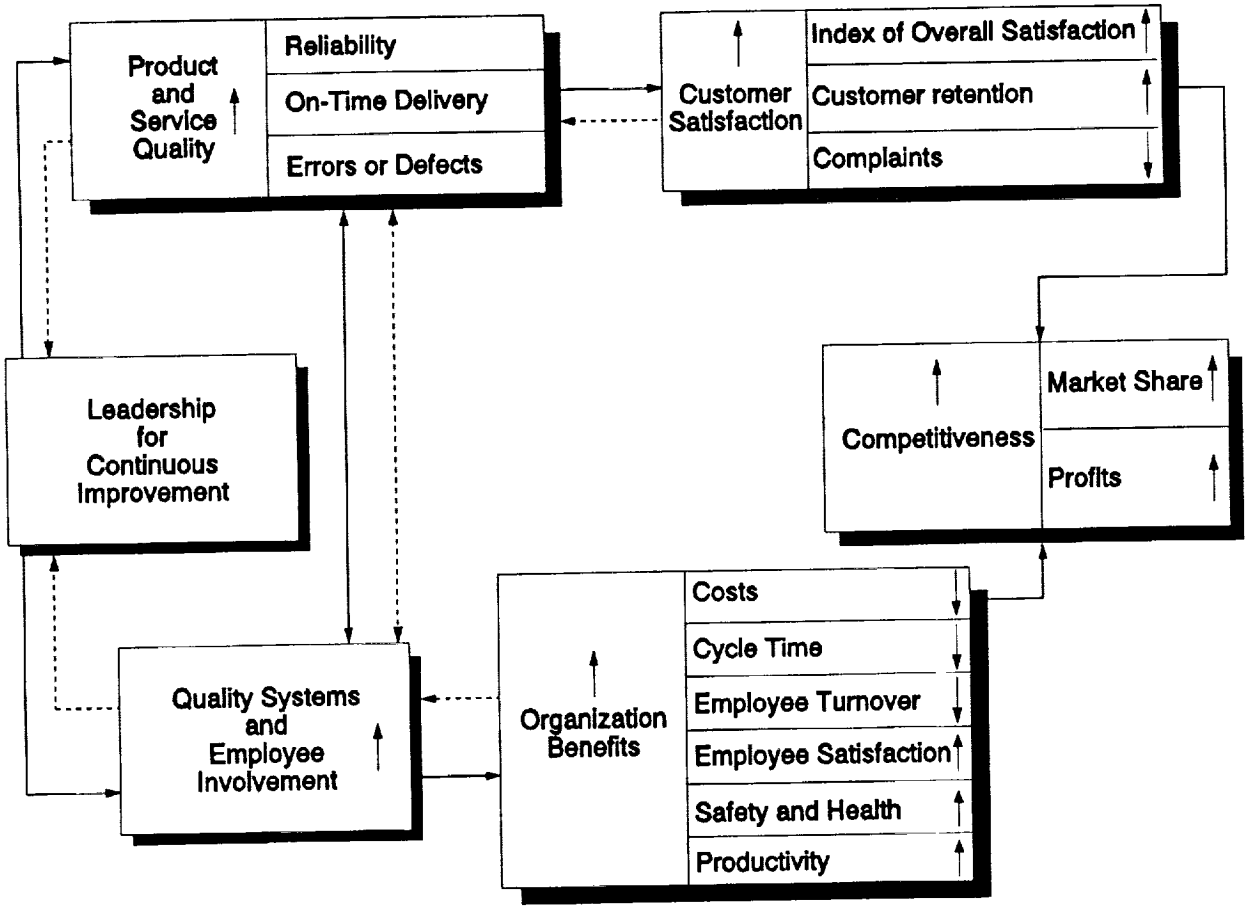


TQM MODEL

Based on the information and data collected by the GAO study, a TQM model was developed. This model shows the interrelationships among the major elements of a TQM strategy. It starts with leadership and concurrently focuses an organization on improving (1) product and service quality and (2) operating and human resource systems. The model stresses the need to integrate the activities aimed at these two areas. It is important to realize that changes in one area impact the other areas. For example, changes in work flow can directly impact employee reward systems.

The model indicates that once changes are made in an organization's systems based on TQM principles, results occur which lead to improvements in customer satisfaction and internal measures of performance such as productivity and employee satisfaction. These incremental improvements over time lead to an increase in market share and profits, and ultimately strengthen a company's competitive position. This model, which we call the **Total Quality Measurement and Management System**, is purposely depicted as circular, representing the continuous nature of quality improvement. Since a company's operating environment is constantly in flux, TQM strategies must remain flexible to react to these myriad changes.

Figure 5.1: TQM Model



GAP CLOSURE SHEET

Prepared By:_____ **Date:**_____

Gap Identification

Short Description of Gap from Application Team: _____

_____ Gap ID No.: _____

Gap Closure Plan

Reconciled Gap Description: _____

Senior Staff Owner: _____

Approach: _____

Comments: _____

Closure Method

☐ Team ☐ Individual ☐ Combine with Gap _____ (Gap No.) ☐ Other

___ Existing CICCP Team _____ (Team Name)

___ New CICCP Team

___ Existing Project Team _____ (Team Name)

___ New Project Team

Schedule

Closure Plan Date:_____

Closure Date Target:_____

Estimated (ROM) Cost

Indirect Hours:_____

Direct Hours:_____

$ Capital:_____

GAP DESCRIPTION SHEET

Prepared By: G. Sperber, J. Botellio **Date:** April 2, 1992

Gap Identification

Business Impact: (H) M L Cost: H (M) L Gap ID No.: VIII.3

Short Description of Gap from Application Team: No process for involving suppliers in our training activities. Subcontractor personnel are not treated as full team members by all S&SS programs.

What NASA Would Like to See

Guidelines Reference: 1.2.2.5 Supplement Reference: 1.2.2.5

Guidelines Criterion: Document that vendor/subcontractor personnel are commensurately involved in teaming activities, including but not limited to: training opportunities, awards/recognition, goal setting and measurement processes.

Supplement Information: Document the level of involvement as specified in the sub-criteria element against the number of eligible subcontractor personnel.

What We See in Place Today in S&SS

Items Covered in Application Report: Teaming with multi-program suppliers, Training and certification in special processes, cleaning and NASA soldering, Supplier Tailored Enhancement Process (STEP I and II), and Supplier of the Quarter Awards.

Other Things We Did Not Write About: Technical Interchange Meetings.

Full Description of Gap:

Same as above.

GAP CLOSURE SHEET

Prepared By: L. Smith, M. Ziarnik, M. Allen, C. Rackliffe **Date:** August 1992

Gap Identification

Short Description of Gap from Application Team: No process for involving suppliers in our training activities. Subcontractor personnel are not treated as full team members by all S&SS programs. Gap ID No.: **VIII.3**

Gap Closure Plan

Short Description of Gap from Application Team: The process for involving our suppliers in training activities is administered inconsistently. Key subcontractor personnel are not treated as full team members by all S&SS personnel.

Senior Staff Owner: P. Barkett

Approach: A) Pre-quotation Technical Interchange Meetings (In Process). B) Statistical Process Control and Total Quality Management Supplier Training (2nd Qtr. '93). C) Establish Integrated Product Development guidelines for all commodities and train all S&SS program teams and key suppliers in their use (2nd Qtr. '93). D) Supplier Reward and Recognition Program (2nd Qtr. '93). E) Establish Supplier Alliance Guidelines through our Certification Process (1st Qtr. '93). F) Special Process Certification (Completed).

Comments:

Closure Method

☒ Team ☐ Individual ☐ Combine with Gap _____ (Gap No.) ☐ Other

___ Existing CICCP Team _____ (Team Name)

___ New CICCP Team

x Existing Project Team Supplier Tailored Enhancement Process Team (Team Name)

___ New Project Team

Schedule

Closure Plan Date:_____

Closure Date Target: 1st Qtr. '94

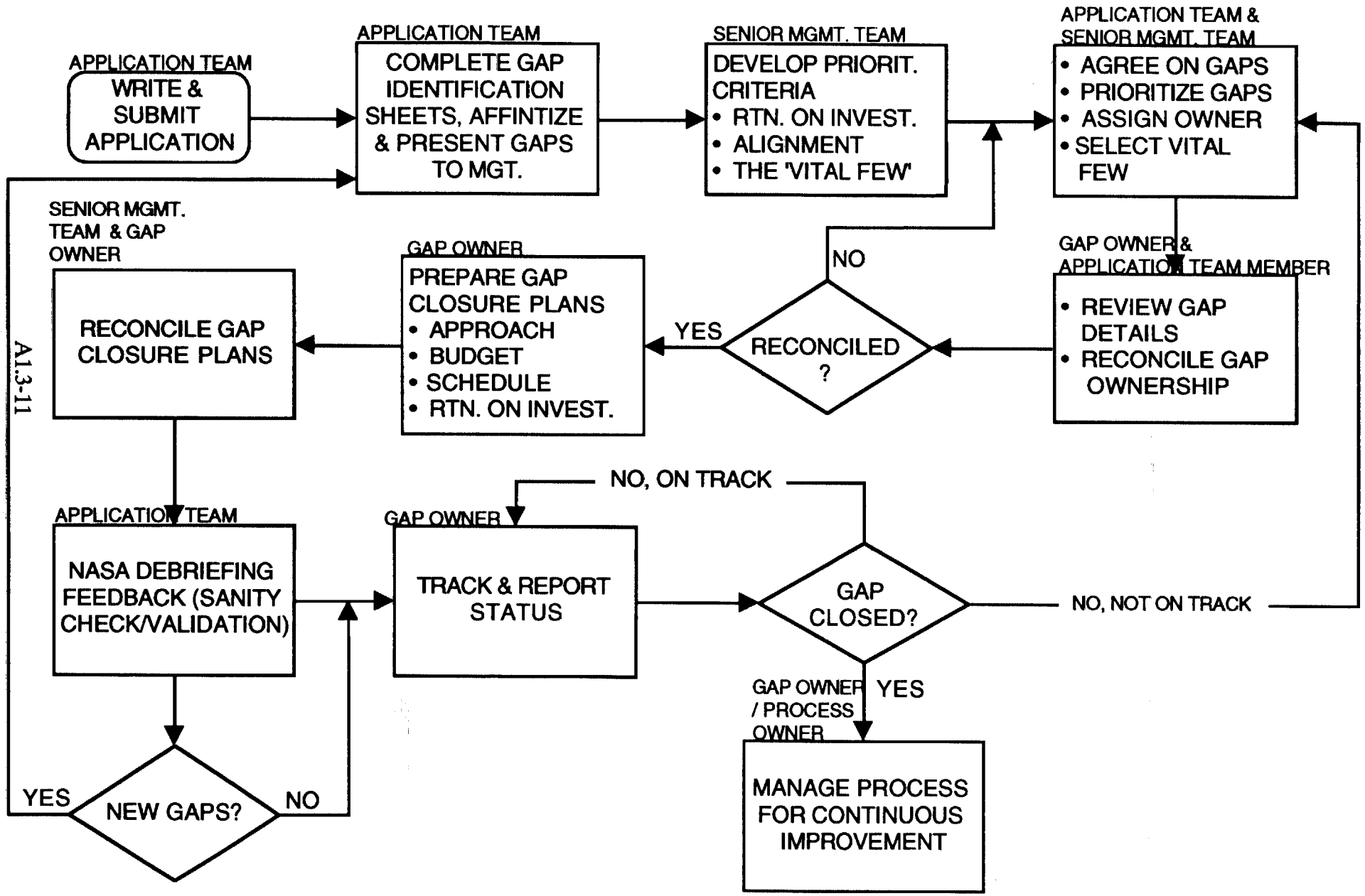
Estimated (ROM) Cost

Indirect Hours:_____

Direct Hours:_____

$ Capital:_____

NASA CRITERIA GAP CLOSURE PROCESS



A2 Results-Keeping An Eye On The Bottom Line

This panel will focus on the vertical integration of organizational results in continuous improvement. Top level assessments and measures include product quality, customer satisfaction, teaming, organizational growth, schedule performance, cost performance, profitability, and competitive posture.

John H. Bitzer, Director, Safety, Reliability and Quality Assurance, Civil Space and Communications, Martin Marietta Astronautics Group, **"The Few Key Measures."**

Dr. Brian L. Usilaner, Senior Vice President, Sirota & Alper Associates Inc., **"What's the Bottom-Line Payback for TQM?"**

IMPORTANT FEATURES OF TQM IMPROVEMENT STRATEGIES

GAO distilled from the 20 companies involved in the study six common TQM features or elements that contribute to improved performance. These were:

* Corporate attention is focused on meeting customer quality requirements.
* Top management leads the way in disseminating TQM values throughout the organization.
* Employees are asked and empowered to continuously improve all key business processes.
* Management nurtures a flexible and responsive corporate culture.
* Management systems support fact-based decision-making.
* Partnerships with suppliers are used to improve product or service quality.

Customer Service

The companies studied understand the necessity of excellent customer service. They spend considerable time and resources gathering information from customers on product and service quality and redesigning systems to ensure customer satisfaction. These companies also realize that there are both internal and external customers. Internal customers are an organization's employees, and it is important to understand their requirements and respond to these needs in the same way as the expectations of external customers.

External customers are those individuals or entities that are the end users or recipients of a product and service. A focus on meeting external customer expectations takes many forms, but in most companies has these common elements: (1) customer-defined quality, (2) new ways of gathering information on customer expectations, (3) new approaches to customer feedback, and (4) understanding the interdependence between meeting the needs of internal customers and those of external customer satisfaction.

Management Leadership

The 20 companies GAO visited could not stress enough the importance of top management leadership in developing a TQM strategy, implementing this strategy and sustaining the strategy over the long haul. Senior managers always led the efforts in these companies, demonstrating, not simply talking about, a commitment to quality through their daily actions. If a number could be set on the amount of time senior management directly spent on quality-related activities in these companies, it was about 20%.

Another critical aspect of top management involvement was the ability to integrate TQM into the company's strategic and operational planning and quickly make major changes in an organization's systems and processes. Without quick action on many of the changes brought about by implementing a TQM strategy, a quality improvement effort can bog down and a company's employees quickly perceive the effort as just another management program sure to die on the vine.

Employee Involvement

All studied companies spent a considerable amount of time and energy ensuring that all their employees were involved in TQM activities. This emphasis goes beyond simply being part of a quality circle or some other group problem-solving process; it is a systematic effort to redesign human resource practices to support quality objectives.

Employee involvement requires management to make many changes in how they manage and treat employees. This change is very difficult for certain managers and much training is directed to this aim. The companies in the study go beyond the typically stated belief that "our employees are our greatest asset" and fundamentally changed their management systems and structures to prove it.

To assess the company's culture and employee attitudes, most of the companies studied use various types of survey questionnaires. These surveys are administered regularly and measure (1) how employees perceive the quality efforts overall and (2) the results of specific quality initiatives. The studied companies say that surveys are an excellent source of information, especially as a method to benchmark their performance and track improvements over time.

Training employees is seen as a critical component of a company's TQM strategy. Most companies begin their training efforts with general TQM awareness that focuses on quality management principles. Training then moves to more specific skills-building that directly supports various parts of the company's TQM strategy.

Corporate Culture

Studied companies recognize the need to better manage their cultures. Culture can be defined as a set of values, beliefs, and behaviors that create a company's unique personality. Many companies have cultures signified by excessive hierarchy, rigidity, and a lack of trust between management and labor. These attributes, all companies agree, are incongruent with the values and philosophies of TQM. Therefore, if a company's TQM effort is to be successful, substantial changes usually must be made in its culture. It should be said, however, that managing corporate culture is no easy task, and the companies studied asserted that substantial changes in culture take about 6 years to bring about.

The type of corporate culture espoused by the studied companies have these attributes: (1) widespread information sharing; (2) fewer formal and informal barriers between departments and among employees, (3) a spirit of innovation, and (4) a high level of employee involvement and satisfaction.

Fact-Based Decision-Making

Knowing what direction to head with a quality improvement effort, and making sure you are on a path leading in that direction, requires information and data. A systematic process to constantly measure and evaluate quality on multiple factors was a common feature found in each company studied. Much of this data gathering takes the form of "statistical process control" techniques which measure the variance of an output to a norm or standard. Companies also use other techniques such as attitude surveys to gather information on those areas where "hard" measurements are not readily available.

Supplier Partnerships

GAO found that the companies studied understood the importance of their suppliers to the ultimate quality of their products and services. Because of this recognition, these companies initiated formal supplier programs that stressed a close, long-term relationship with a smaller number of suppliers. Quality became one of the major criteria when selecting a supplier, instead of simply cost, which was the main criterion previously. Suppliers showing a willingness to take the appropriate actions to continuously improve their products and services were made "partners in quality" and were closely integrated with a company's operations.

GAO STUDY CONCLUSIONS

GAO states in its report that TQM has widespread applicability for all U.S. companies. GAO believes that the diverse nature of the companies involved in the study, along with their overwhelmingly positive results on the four broad indicators measured, demonstrate that well-designed and implemented TQM strategies have a positive economic impact. Those companies that have made the most progress have the following similarities:

(1) Customer satisfaction is a paramount company objective. Central to this goal is not simply meeting customer needs as they pertain to existing products and services, but being out in front of customer's requirements with new products and services. The Japanese call this "Kansei," which means developing innovations that delight and surprise customers. The differentiation between simply meeting customer requirements and "Kan-sei" is very important and directly relates to leadership and innovation.

(2) Top management, most importantly the CEO or President, must provide active leadership to drive the principles of quality throughout the organization. A critical component of this leadership is the ability to continually sustain and revitalize quality strategies. This process requires constant communication and information sharing.

(3) Quality, its philosophy and its practical application, needs to be clearly understood by all organization members. Training usually takes center stage during this process and is seen

not as a one-time activity but as a continuous process. Also, management must ensure that once employees are trained, there are systems and processes in place allowing them to utilize this new knowledge and the vast array of quality tools and techniques.

(4) An organization's culture must be one that supports the principles and philosophy of quality. Culture is an outgrowth of a company's history, and is manifested in its structures, systems and processes. For example, a company cannot espouse employee involvement and have a management structure and philosophy that emphasizes narrow spans of control and autocratic management. An organization's systems and processes must be aligned with quality principles and its specific quality strategy. If these systems and processes conflict with quality principles and strategies, tension will result raising serious barriers to successful quality improvement.

(5) Companies need to push quality improvement efforts down to the lowest levels of the organization. Employees at all levels need to be trained, involved and rewarded. Central to total employee involvement is a focus on strengthening employee commitment and implementing continuous improvement processes.

(6) Quality improvement efforts should develop and implement better and better systems for gathering, analyzing and using data on all aspects of a company's performance. Both hard and soft data should be gathered. Management by fact must become the norm and this requires innovative approaches to gathering and analyzing data so that it is relevant and easy to understand.

(7) An organization's suppliers must be made full partners in the quality improvement process. Suppliers should clearly understand what is expected of them and support efforts to improve the quality of their products and services. If suppliers are not up to this task, new suppliers should be found.

GAO notes that a company's improvement in performance as a result of implementing a TQM strategy is neither quick nor without its ups and downs. It took an average of 2 1/2 years, with a range of 1 to 5 years, for the 20 companies included in GAO's study to realize initial benefits. And most of these companies have been actively pursuing quality improvement for well over a decade.

IMPLICATIONS OF RESULTS--WHERE THE GAPS EXIST

Many current attempts at implementing TQM strategies fall well short of expectations. Why? Most of these efforts lack a comprehensive approach to continuously improving quality. Many quality efforts do not encompass the seven Baldrige Award criteria: They focus on those criteria with which they are most comfortable or have an existing expertise (e.g., process management or training). Additionally, many organizations are not changing their existing culture, systems and processes to sustain a quality improvement strategy. These are practical approaches.

Companies' approaches to implementing quality management systems usually fall into two categories: (Little) "q" and (Big) "Q". "q" is defined as those quality efforts that are program-oriented. These tend to emphasize training and other quality improvement tools and techniques. They lack an overall strategy and have little top management support. "q" quality efforts are not integrated with a company's core systems and processes--they remain parallel to, and sometimes conflict with, these core systems and processes. "Q" quality improvement efforts are led by top management, have well-articulated strategies, and are integrated into the very fabric of a company. "Q" quality strategies demand fundamental changes in a company's culture, structures and processes.

What is important about the differences between "q" and "Q" quality efforts is that while "q" might result in some improvement over the short term, these efforts almost always wither over time and for all intents and purposes, disappear. The time period for this disintegration varies, but it is usually within three years. The following chart depicts how "q" can improve performance over the short-term, but eventually hits a wall with a rapid decrease in improvement thereafter. With "Q", quality improvement passes through the 3 year wall and continues.

Figure 6.1: Little "q"

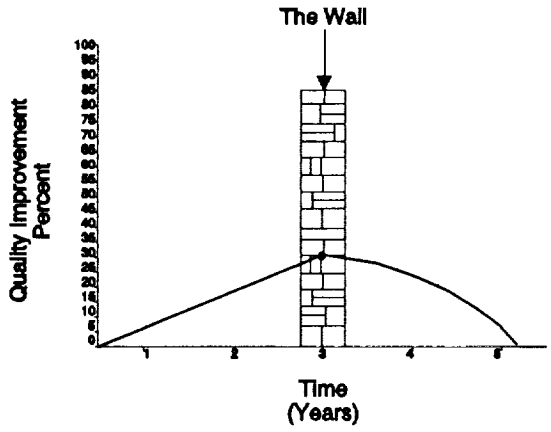
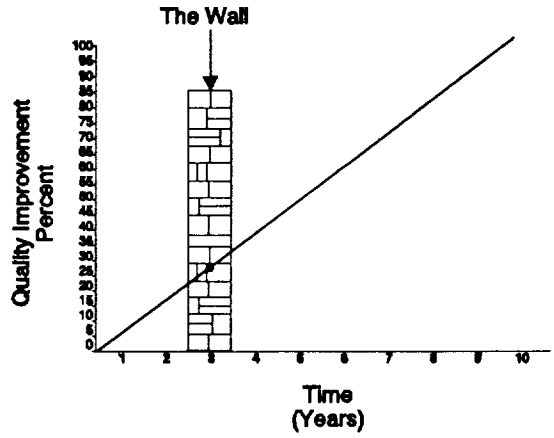


Figure 7.1: Big "Q"



To fully integrate quality strategies into company systems and processes, all of the organizations involved in GAO's study place a heavy emphasis on effectively managing their human resources. These companies' HR departments are an integral part of their quality improvement efforts, and the Human Resource component is always a part of quality improvement decision making. One HR-related area that the studied companies have difficulty with is how to effectively tie reward systems to quality improvement efforts. Companies have tried various types of performance-based reward systems like gainsharing, but few companies have expanded these systems throughout their organizations. Recognition programs have, however, gained an important foothold in many quality improvement efforts. The studied companies have spent considerable time and effort developing and implementing such programs. Whether these programs consist of small gifts or simply a name or team mentioned in a company newsletter, they are clearly becoming widespread with reported positive results.

CONCLUSION

A major gap in the knowledge about TQM, empirical evidence about its impact on a company's economic performance, has been partially satisfied by the GAO study. The study indicates that well-designed and implemented TQM strategies can significantly improve an organization's effectiveness on many measures of performance. However, this study was limited to only 20 companies and more research is needed to build upon the GAO findings.

Another major gap in knowledge, how to effectively implement and integrate TQM strategies, needs much more research and careful analysis. Based on visits and analyses to date, it is apparent that many companies are not implementing comprehensive quality improvement strategies. And even if a strategy is well designed, it is usually insufficiently integrated into an organization's existing systems and processes. Quality improvement, therefore, becomes just another management fad that is not sustained.

Brian Usilaner, D.Sc.

Brian Usilaner is a Senior Vice President with Sirota & Alper Associates Inc. Brian has more than 25 years of experience, working with a wide variety of organizations, designing and implementing integrated approaches to improving product and service quality. Brian has held positions with the U.S. Office of Management and Budget and the U.S. General Accounting Office. At GAO, Brian developed nationwide programs aimed at improving U.S. productivity and competitiveness through quality enhancement. He has conducted innovative research in such areas as employee involvement, performance-based incentive systems, and service quality.

A noted speaker and author, Brian has been a keynoter at many conferences and workshops and has published several articles in the fields of productivity, quality and employee involvement. He is an adjunct professor at the University of Maryland's Graduate School, teaching courses on quality management.

Brian serves on the Board of Examiners of the Malcolm Baldrige National Quality Award and is an active member of such professional organizations as the Quality and Productivity Management Association and the American Society for Quality Control. He holds a D.Sc. in Management Science from George Washington University.

FOOTNOTES

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2 Noriaki Kano et al., Quality, Union of Japanese Scientists and Engineers (Tokyo: April 1, 1983)

3 The PIMS Letter on Business Strategy, The Strategic Planning Institute, Number 4 (Cambridge, Mass.: 1986).

4 Current Practices in Measuring Quality, The Conference Board, Inc., Research Bulletin No. 234 (New York: 1989).

5 Quality: Executive Priority or Afterthought?, American Society for Quality Control (Milwaukee, Wis.: 1989)

6 Daniel R. Denison, "Bringing Corporate Culture To the Bottom Line," Organizational Dynamics, (Autumn 1984).

A3 Capturing Customer Satisfaction

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This panel focus on methods for identifying and capturing the right data on customer satisfaction, in terms of technical requirements, customer expectations and general goals and objectives. The panel examines customer satisfaction in service, software and hardware organizations. Case studies will focus on both positive and negative experiences.

Gregory S. Trachta, Program Director, Space Systems Operation, Paramax Systems Corporation, **"Partnership with the Customer."**

John R. Belmont, Vice President, Information Services and Operations, Grumman Data Systems, **"Quality Customer Measures."**

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PARTNERSHIP WITH THE CUSTOMER

Gregory S. Trachta
Paramax STSOC Program Director
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N94-13157

PARTNERSHIP

This discussion will recount some historical observations about establishing partnerships with the customer. It will suggest that such partnerships are established as the natural evolutionary product of a continuous improvement culture. Those are warm, ethereal terms about a topic that some people think already suffers from an excess of hot air. We will focus on some real-world activities and workplace artifacts to show there are substantive concepts behind the TQM buzzwords.

PARAMAX MISSION

Paramax sustains and maintains the software and data systems for ground-based operations at Johnson Space Center. We are a member of the (RSOC) Rockwell Space Operations Company (RSOC) Team that provides Space Shuttle and Space Station operations for the Mission Operations Directorate.

Johnson Space Center owns a huge body of software (nearly 20 million lines of code) operating in a diverse mainframe, minicomputer and work station environments. The Paramax Mission is to ensure the operational suitability and readiness of this software baseline to meet the specific mission objectives of the Space Shuttle Program.

We maintain the software tools used for mission planning, which starts years before a launch, and those used to manage the data that define flight-specific reconfiguration requirements, as well as the real-time systems that simulate operational conditions for pre-mission testing and training. We are also accountable for the real-time software that provides command, control and communications capabilities in the Mission Control Center.

Maintaining the suitability and readiness of this operational software baseline for manned spaceflight missions is a sobering responsibility. Process management and continuous process improvement are essential to provide safe and reliable software services. Systematic and methodical approaches, with everyone's full and proactive participation, must be the norm.

GEORGE M. LOW

We have found that the George M. Low benchmarking process provides a comparison to the best practices used in the NASA contractor community. The judging process, which compares our practices systematically against standard criteria used industry-wide, allows us to find our areas of strength and weakness.

The systematic and objective characteristics of this evaluation process help us bring order to what can be a confusing as well as dynamic business. The resulting performance critique gives us feedback to provide lessons learned and establish improvement plans. Each year we have participated in the George M. Low award evaluation regimen, we have made significant improvements to our total performance as a direct result.

EXCELLENCE TEAMS

Our line organizations mesh directly with a set of formally established excellence teams that have a mandate to take ownership of a set of processes and focus on their improvement. Each team has a leader who acts as a coach or mentor to the team members. Every team member is expected to help define and improve processes, remove barriers that cause process problems, and in accepting accountability for the team's results.

Each Team maintains its own records, analyzes its own processes, implements improvements and interacts with management and other teams to define and resolve issues. Management and non-management employees participate in these teams. Management is responsible for the teams' success, but each team has a large degree of autonomy in setting its own agenda.

The teams communicate internally and externally by posting relevant information on bulletin boards called Excellence Boards. These boards identify the teams and display their respective priorities. Mission statements, metrics trends, corrective actions and other information relevant to the teams' activities and personalities are displayed as well.

We have some examples of these boards in our booth at this symposium. If you go by and take a look, you will see that a great deal of pride and creative energy has gone into the information displays, along with an overriding sense of utility and functionality. Excellence Boards are not departmental bulletin boards; they are working tools. The boards are structured and controlled communication vehicles that provide visibility for our continuous improvement efforts.

TQM IMPLEMENTATION

Over the six years we have been at Johnson Space Center, we have found that our TQM implementation has produced a strange dichotomy. As our TQM involvement intensified, two classes of activities emerged. There was what many referred to as the "Quality Stuff," which

seemed to consist of meetings, discussions, newsletters, goal-setting sessions and great periods of introspection. There also was what was often termed "real work," which consisted of people working to avoid errors, automating manual operations and generally advocating efficiency.

We found, in fact, that two camps evolved: the one doing "Quality Stuff" and the one doing "Real Work." The management team became agitated by this development and spent a great deal of energy worrying how to get the "Quality Stuff" people working together with the "Real Work" people to apply TQM in managing the business.

BOTH CAMPS

Eventually, both camps discovered that each was essential for a successful enterprise. We realized that some of our improvement activities were focused on what might be called "operational" things. These activities were aimed at classic process improvement and greatly emphasized doing things right the first time. People engaged in these activities believed they were doing the "real work."

Other activities were focused on what we have come to recognize as "enabling" things. Their intent was to remove barriers and make sure effort was spent doing the right things. People engaged in these activities were often referred to as doing "Quality Stuff."

The realization that both of these activities were part of the same thing was a major consciousness-raising milestone. It resulted in questions being asked that previously would not have been considered useful by people with the right information to pursue them. Doing things right and doing the right things are the inside and outside of the same circle.

METRICS

As we learned to improve processes and remove barriers, we also learned that appropriate metrics can support coherent goal-setting. By establishing program-level goals in the areas of quality, productivity, work flow and team-building, we were able to focus on processes and potential barriers at all levels within the organization. The program-level goals translated at all organizational levels into common metrics that aggregate naturally to provide a vertical metrics roll-up. Everyone's contribution to the top-level goals is measurable and actionable.

METRICS AGGREGATION

While vertical metrics aggregation is a matter of communicating goals at all levels in the organization, Metrics are aggregated horizontally by using the Oregon Matrix. This allows us to develop a performance index from a set of measurements that are mathematically unrelated. Each measurement is assigned a weight, and its matrix value is aggregated into a weighted average score. The matrix is calibrated periodically by setting current measurement trends at the matrix

value "3" level, the current goal at the "10" level and the unacceptable limit at the "0" level. Measurements are taken periodically, and trends for the matrix scores are calculated. There are many benefits in aggregating metrics this way. They help us understand complex relationships between seemingly independent variables, discern major contributions to problems or successes, and develop an overall sense of performance levels.

COMPOSITE TRACK

Composite averages, which we measured on our program-level metrics during the twelve months ending each July, show a flat trend through December, followed by a sudden drop and a steady improvement since.

Each December we analyze our metrics process, compare it to our goals and make adjustments as appropriate. Last December we found that some of our raw measurements were not good indicators of the factors they were meant to convey, and we found that other measurements were calibrated in such a way that changes did not appear in the composite index. We rebaselined our measurement definitions and recalibrated the matrices, and the scores (not performance) dropped as a result and then trended upward, reflecting improvements implemented in the spring.

PROBLEM PREVENTION

The goal of continuous improvement is to move from reactively solving problems to proactively preventing them. To people in the software business, a major questions is: "How heavily is the customer affected by errors in the software?" Our goal is to prevent software errors from appearing in the operational baseline. We use a defect-density measurement (Software defects per million lines of code in the operational baseline) to track our performance.

This chart shows our defect-density since we started handling Shuttle software. You can see that the trend is in the right direction. Some people believe such density reductions are the natural result of the software's maturation, and there is some truth in this. If software is static, eventually all the defects can be found and corrected. However this baseline has not been static. It grew by almost 50 percent during the past six years and huge amounts of changes have been made in it. We keep defect-density data normalized to the quantity of software that has been changed, as well as to total software, and both measurements trend downward.

CUSTOMER RESPONSIVENESS

Metrics also support customer responsiveness. The length of dwell time required to resolve critical problems and the backlog of unresolved discrepancy reports are just two areas where our customer's expectations are highly visible. These are global measurements that are part of the top-level metric trends that tell us how we are doing.

TQM SEASONS

After pursuing continuous improvement for several years, we made another unexpected discovery. We went through seasons of awareness and opportunity much like annual seasons when certain conditions prevail and provide windows of opportunity. But unlike annual seasons, we found that as the TQM years cycled through their seasons, there was not an automatic progression. We found it was possible to get stuck, and no amount of process improvement and enabling activity would get us through that season until its major event had occurred. Imagine winter lasting until everyone has decorated a Christmas tree, or Fall until everyone had carved a pumpkin.

We began in a happy Summer of process optimization. Everyone had a favorite process improvement, there was tremendous enthusiasm and it seemed possible to dream of something almost like spontaneous combustion or perpetual motion, continuous improvement directly to the fabled field of zero defects. This was how we began.

Then we noticed the leaves turning brown. At first we reacted like a September butterfly, flapping our wings, making gaudy and colorful displays and trying to go on as before. However, we suspected things would not remain the same. Gradually, Management began to suspect that TQM was trickier than it looked. Behavioral change by our employees would not suffice; we would have to change as well.

We launched with renewed enthusiasm into an Autumn of management adaptation. We found that management had a role to play in continuous improvement that was different and much more difficult: it required more listening and leadership. This challenged the management team to redefine a value-added role in a world whose process owners could change our own way of doing business. After a while, we began to see that management could become an organic part of continuous improvement, and we felt much better.

Then the pond froze over. We suddenly entered a Winter of uncertainty as an unstated concern began to crystalize. The concern finally was expressed with the comment, "That's how we should do it, but the customer will never go for it." There was a widely held belief that process improvement was limited and that certain inefficiencies and absurdities could not be overcome because the customer demanded them. Voicing this concern enabled us to solve it, and we began -- at all levels -- to work with the customer on things perceived as issues. The excellence teams in particular lead the way in customer involvement, establishing well-understood expectations and means to measure our performance in meeting them.

Then another surprising thing happened. Customer involvement lead to a springtime of renewed employee acceptance. Activities that had been considered extraneous or theoretical suddenly became bona fide customer requirements and, therefore, "real work." This renewed buy-in lead to

another Summer of process improvement and further evolution of the management team, to more sophisticated customer alignments, etc.

As New Englanders have always known, the key to the cycle was Winter. Customer focus was the essential ingredient to permit continued progress.

CUSTOMER INVOLVEMENT

Customer Involvement is not a buzzword. It is a definable process that can be formalized as a series of activities. The most important step is the first: customers must be identified. Our excellence teams are responsible for displaying, on their excellence boards, formal identification of their internal and external customers. This is by no means a trivial task.

The second step is to document a set of customer expectations that can be mutually understood by team members and customers. Getting customers to concur in writing is important, and displaying that agreement on excellence boards is essential.

Once expectations have been established, a process to assess them must similarly be accepted mutually. This ensures that teams and customers periodically review and agree on how well expectations are being met.

A customer score card is an important refinement of the assessment process. It allows metrics to be established that objectively depict the team's conformance to expectations.

Finally, the score card process should be made part of the normal performance metrics process. This ensures that meeting customer expectations is not deemed just another set of performance criteria, but are **the** criteria. Our excellence teams do this by developing Oregon Matrices of customer-related parameters, and incorporating these into the assessment and score card processes.

INVOLVEMENT PROCESS

Since customer involvement is a process, it can be measured like any other. Our excellence teams are progressing through the customer involvement steps, and many teams have developed some very effective tools to ensure clear communications between team members and customers.

Nearly all our excellence teams have formally identified their customers. In addition three-fourths of the teams have signed mutually accepted expectations with their customers, and approximately two-thirds have assessment processes and score cards in place. However, only forty percent of our teams have integrated their customer score cards into their normal metrics process, and our big challenge for next year is to increase this number dramatically.

CUSTOMER IDENTIFICATION

There are some examples of customer involvement artifacts that our excellence teams have developed. The first example shows tools used to make the customer identification formal and visible.

The first of these is from a team that provides definable products and services to a variety of internal and external customers. The second is from a team with a hierarchical structure organized around work functions. The third is a product-oriented list that goes a step further: expectation identification.

EXPECTATIONS

Expectations must be both written and accepted. The first example here is a "performance pact" document. The second takes the form of a creed (the sign-off was on the next page, which is not shown here). The third again carries expectations further, and includes measurements and analyses.

ASSESSMENT

The assessment process must routinely include the customer. The first example shows monthly feedback from the customer on specific expectations. The second is a very objective cooking survey. The last incorporates a score and the weighting of different assessment criteria.

SCORE CARD

The customer score card makes periodic assessments object and visible. The first example establishes success criteria and displays the customer's grade on each. The second is very similar. The third provides an aggregate or overall score that can be entered into a metrics process.

INTEGRATED METRICS

Finally, customer assessments should be integrated into the normal metrics process. The first example of this is a standard Oregon Matrix showing the customer's assessment, along with objective criteria important to the customer. The second illustration is a trend chart showing the Oregon Matrix index over time. The third is an example of a specific metric related to a customer expectation on rework that shows how the customer assessment process relates directly to preventive action and process improvement.

IN CONCLUSION

There really is no conclusion, since the only thing after continuous improvement is another opportunity. There are some observations, however. First, TQM is not a miracle; it is a change,

and change brings confusion to any organization. Management's role is more important than ever in dealing with this confusion, but the role is very different.

Success with TQM is uncertain. It can be done incorrectly. An overemphasis on either the "real work" or "quality stuff" without recognizing the importance of both will produce either highly centralized, authorization organizations which pretend TQM is enlightenment, or loose confederations of mobs and a management team in abdication.

But, the benefits are worth the risk. The guiding principle is a simple definition of success: a joint venture with customers.

OMIT

Quality Customer Measurements

John R. Belmont, Vice President
Intercorporate Computer Services, Grumman Data Systems

The Grumman Quality process, or GQ as we call it, came to the company in 1988. The goal: to move Grumman to world class status by 1995. The blueprint for reaching that goal is called Vision '95, a plan to improve the way we do our work, encourage employee involvement and empowerment, most importantly, create a leadership focus on customer needs and customer satisfaction.

Besides being Vice President of Intercorporate Computer Services for Grumman Data Systems Division, I am the Data Systems' Quality Executive. My job is to create an environment which ensures that Vision '95 goals are achieved. Like most of you, we have had successes in our Quality Process as well as failures. But our successes far outnumber our failures and we are now seeing significant results. I've been asked to discuss one of our most significant successes, namely, our approach to capturing customer satisfaction.

Before I do that, let me give you a brief background about my organization. Intercorporate Computer Services provides all the computing systems, services and support required by all divisions in the Grumman Corporation. Our strategic objective is provide information systems and state of the art tools at the lowest possible cost, which will improve the competitiveness of those divisions. A key measure of success is customer satisfaction. Achieving internal customer satisfaction was a goal that had eluded not only us but many in the data processing business as we called it in the '70s and early '80s. To be honest, customer satisfaction was not one of the top priorities back then. The user of our services was considered an element of the process, but certainly not the most important element.

With the introduction of the Grumman Quality process, life changed. We learned to listen more to what our Customers were telling us and then implementing what he wanted - not what we thought he needed.

A key element of all quality programs is measurement. In late 1990, we identified our most critical business processes and presented our approaches to measuring them. We knew that improved measurement was essential to meet our quality challenges. But that conclusion frustrated us at first because, like most many data processing facilities, we already had more measurements than we could use. So we began an analysis to determine what meaningful measurements to keep, and meaningless measurements to eliminate.

We also had to ask ourselves, What business we were really in? The answer came back that we were a service bureau and that we should be meeting the needs of our customer. We then focused on those processes which deliver service to the customer.

As we looked at our existing measurements in that light, we saw that yardsticks such as channel utilization, CPU-busy, disk utilization, etc., really did not measure the service level the user experienced. If we truly wanted to know whether the customer was satisfied with our services we had to do the obvious: ask the customer.

We wanted to learn the customer's perception of the services delivered by our data centers. We needed some measurement that answered the following questions: Did we meet the customers's requirements? Are we helping the customer get the job done more efficiently? Are we providing our service in a way that bespeaks quality? Is the customer happy with our service and if not why?

We wanted this measurement to be simple. Back in elementary school, report cards were a measure of success in meeting the challenges of learning. We asked ourselves, why not use a similar system to measure how well our data centers meet the challenges of our customers. We settled on a simple, three-choice rating system: Good, Fair, or Poor. We then proceeded to identify the elements of our service which were to be measured.

Sounds so straightforward, doesn't it? But it also drove us to confront a fundamental decision. Faced with the prospect of having a very visible report card of our performance, we had to ask ourselves if we could afford such a level of openness and honesty. Will the customer be fair? Do we have any chance to get good grades on this report card?

Courage was needed. If we were to be in the service bureau business, we had to know how our customers perceived our services. If we were afraid to ask our customers that hard question, and let the world see their responses, we shouldn't be in the business and wouldn't be for long. We decided to proceed and we also decided to let the customer take part in developing this report card.

We set some ground rules. Honesty and fairness were fundamental. The customer is always right. The customer agreed to take the time to define problems so we could understand what was keeping us from providing good service. And finally, the customer had to identify an individual who would be responsible for insuring that the grades provided, actually reflected the opinion of the users he represented.

Each customer group worked with us to select the services they would grade. Different customers selected different services. For example, some customers selected various operating environments such as on-line systems, data base systems, batch systems or elements such as Cray or VAX processing platforms. Other customers focused on application systems such as payroll or inventory.

The report cards eventually developed were called "star charts," because good report cards contain lots of stars. The scoring of each element (platform, service or application), on the star chart (green star (good), yellow bar (fair) or red ball (poor)) is based on how the customer views, on a daily basis, each service we provide. The review by the customer of the scores on all platforms, results in the rating (star, bar, or ball) of our service for the day. This process is performed for each day of the month.

Daily platform and service ratings are kept on one chart for each month. Problems with a particular platform pop off the sheet and are easy to identify. On a monthly calendar, the customer rating for each day is displayed. These charts, which clearly illustrate our customer's view of our service for the month, are displayed throughout the data centers and are available to management on-line. Moreover, the president of the division reviews these measures of our performance.

This tool helps us to focus on continual improvement. When we first starting reviewing those charts, we saw that Monday was our worst day of the week. Why? We do most of our changes over the weekends, so naturally problems show up on Mondays. We now have what we call a Quality Work Group improving our change control process. We will monitor the effectiveness of improvements by tracking Monday performances.

One performance chart shows monthly the percentages of good, fair and poor days. Targets for improvement are identified and tracked in terms of defects per month. A defect is defined as a day a customer does not view our service as good. This chart tracks the results of our continuous improvement efforts through the year.

The star chart system is so effective that we have implemented it with several of our external customers and have adapted this approach to rate our vendors. We have established vendor evaluation elements which are basically the same for all vendors, they fall primarily into three categories: product, service and support.

The benefits of this approach to measuring customer satisfaction are clear. It insures communication on both sides. It also focuses the attention of the supplier on areas important to the customer, improves customer-supplier alignment, measures and tracks improvement efforts, and, very importantly, it shows the customer how much we care.

The keys to success in measuring customer satisfaction are to get the customer to identify the services that are most important, then work out the process of communicating and reporting. Finally, if the system is to be successful, it's essential that the measurements be visible to both the customer and to the supplier of the services.

As an enhancement of our star chart tool, we are now going beyond the elements of the data center environment to all aspects of the Data Systems Division's service. We are also looking to move the grading of our services from a representative of a large group down closer to the user level. We are working on coordinating the results of this tool to those from other measurements, such as customer satisfaction surveys.

The star chart system works. The users love it, it keeps us on our toes, and we have seen a real improvement in customer satisfaction and significant improvement in our customer relations as a result.

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B Moving From Management To Leadership

This session will delineate the transformation process needed to create a culture in which leadership is developed, nurtured, and integrated with existing management practices. Actual case studies with lessons learned will be presented.

B1 Leadership Versus Management

This interactive panel will focus on the distinction between leadership and management, and why a leadership style is required to transform organizations into the TQM culture.

William L. Ginnodo, Executive Director, Quality and Productivity Management Association, **"Leadership Versus Management: How They're Being Redefined by TQM"**

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P. B1.1-1

Leadership Versus Management: How They're Being Redefined by TQM

William L. Ginnodo, Executive Director, Quality & Productivity Management Association

"We were taught to take names and kick ass, and the ones who did it the best got promoted. The best intimidator got ahead."

With his four peers nodding in agreement, Dick Painter, a first level supervisor at Abbott Laboratories' rubber products manufacturing plant in Ashland, Ohio was telling me what it's like to manage self-directed work teams.

"Now," he continued, "we're helping the teams make a lot of decisions. We're more like teachers and coaches."

Wait a minute, I thought. *Did he say employees are making a lot of the decisions?*

"What kind of decisions are the teams making?" I asked,

Jeff Armbruster, another of the supervisors answered: "Most of them are planning and scheduling production runs, talking directly to maintenance when they have equipment problems, and they're filling out purchase requisitions. We're also beginning to teach them how to budget."

"In my area," chimed-in Ralph Kirkpatrick, " there's no supervisor working with the night shift team. They do everything I do on the day shift. It's working out real well."

A little while later, I asked the plant's manufacturing manager, Frank Katkaveck, for his perspective.

"We want to become a world-class manufacturer," he said. "In order to do that, we need a well-trained, multi-skilled workforce that understands the business. We've got 42% of our 350 production associates in self-directed work teams because it makes good business sense. Our job as managers is to provide leadership, not dictate, and to get rid of the roadblocks so people can do their jobs well."

That's basically what Al Scott and Sarah Nolan said when I talked to them. In fact, that's what I'm hearing all of the TQM leaders say. There's a pattern to this.

Al Scott is plant manager of Wilson Sporting Goods' golf ball manufacturing plant in Jackson, Tennessee. He and his management team are also focusing on a world-class manufacturing strategy. Fifty-five percent of his 650-person workforce is actively involved in continuous improvement (problem-solving) teams.

Al told me, "Our supervisors and managers have become coaches, and employees have become associates. We're giving as much freedom as possible to the associates, who are close to the action. Our coaches are responsible for removing barriers. They ask, 'what can I do to help you do your job better?' Our goal is for everyone to be a coach—to coach themselves and to influence others."

Sarah Nolan is president of American Express Life Assurance Company's Investment and Insurance Services Group in San Rafael, California. Sixty percent of IISG's 450-person workforce is in self-managing teams, which are cross-functional and customer-focused. The teams manage their own workloads, set priorities, conduct peer evaluations, track team performance and continually seek ways to improve their processes and customer service.

During my interview with her, Sarah told me, "Management is the single, largest obstacle to change, because you're challenging the way they rose in the organization. It takes time for managers to pick up what it means to succeed in a total quality environment. But they change when they see the power of the new way, the performance of the teams, the numbers that track the level of customer service, and the pride that people have in what they're doing. Business results are the outgrowth of that kind of pride."

What kind of business results? How about a 30% improvement in turnaround times on applications and policy changes, while the number of employees has decreased 20%. And at Wilson's golf ball plant, a decrease in late shipments from 293 in 1985 to 18 in 1991, and an increase in market share from 2% to 17% during the same period. And at Abbott-Ashland, an increase in one team's efficiency from 65% to 120%, and another team's 27% increase in production with only a $500 capital investment.

The point of these stories is that there are real people, in real plants and offices, who are getting real results by managing differently. And such stories are not limited to the highly visible examples, such as the winners of the Malcolm Baldrige National Quality Award. They're being told—in *Fortune, Business Week, Harvard Business Review, Industry Week, Quality Digest* and a host of other business magazines and books—about many large and small manufacturing, service, health care, governmental and educational organizations.

They are organizations in transition. Their managers would tell you what many have told me: "We've come a long way, but we have along way to go."

How are they managing differently—and *why?* Let's go back to some basics.

Ask any group of executives, managers or supervisors to define "management" and they'll readily respond: "getting work done through people." Ask them what the primary tasks of management are and they'll say: "to plan, organize, direct and control." Somehow—through education, word-of-mouth, or modelling others' behaviors—most people have come to accept that this is what management is all about.

But, ask the same people if there is anything wrong with the Plan-Organize-Direct-Control approach, and they'll just as readily tell you that it leads to:

- underutilization of employees and their ideas (because managers are expected to solve the problems)
- preference for the status quo, instead of improvement (because managers already have plates full of operational priorities and crises)
- ignoring of customers' real needs (because the focus is on internal operations, and there is no time to interact with customers) and
- organizational performance and results that are far less than they could be (because employees are underutilized, customers' needs are ignored, and there's little emphasis on improvement).

Turn this line of thought around—as the Frank's, Al's and Sarah's have done—and you come up with an interesting conclusion:

- Our performance and results are not what they should or can be.
- We can do better if we do a better job of satisfying customers.
- To do that, we need to improve.
- And, to improve, we need to use the minds, as well as the hands, of our employees.

The conclusion? Therefore: The Plan-Organize-Direct-Control approach to management is

faulted and needs an overhaul. Now, we don't want to throw away the *generic activities* of planning, organizing, directing and controlling; they're vital to successful management. But we do need a new way to think about the *primary tasks* (the mindset) of management.

Let's not get theoretical as we do this, however. Instead, let's look at what real people, in real plants and offices, are already doing.

I've had the good fortune, during the past seven years as editor of *Commitment-Plus* newsletter, to interview several hundred executives, managers, supervisors and employees inside 70-plus organizations that have quality, productivity or service improvement efforts under way. Abbott-Ashland, Wilson-Jackson and AMEX-San Rafael were among them.

Each story is unique, and each individual has a different way of expressing what was done. Nevertheless, a clear pattern was discernible as I tried to uncover the primary tasks of management in these leading-edge organizations. This pattern is particularly clear in organizations that have committed themselves to building a total quality culture—a work environment in which customer-focus, continuous improvement and employee empowerment are the primary guiding principles. (Remember, we concluded earlier that the Plan-Organize-Direct-Control approach to management doesn't focus on customers, improvement and employee ideas.)

This brings us to total quality *management.* TQM is, to put it simply, the way one manages within a total quality culture.

So, how are those real people, in real plants and offices, who are building total quality cultures, really managing? In other words, what are the *primary tasks* of management in the leading-edge organizations?

First, there's *leading,* which involves articulating a vision, values, strategies and goals; aligning policies, practices and business plans; improving processes; organizing, communicating and "walking the talk" of total quality.

Next, there's *empowering*, which is routinely using self-directed, cross-functional, process improvement and corrective action teams; devoting resources to education and training; recognizing and rewarding improvement efforts and success; consulting and coaching employees; removing barriers.

Then, there's *assessing*, which involves surveying customer and employee opinions; using quality, productivity, and service measures; statistically measuring production processes; benchmarking the best organizations.

And, finally, there's *partnering,* which involves closing the performance gap by working with customers, suppliers, unions and schools; and working with governments and community groups to anticipate and resolve environmental and other issues.

I think you'll agree that this Lead-Empower-Assess-Partner approach to management creates quite a different mindset than does Plan-Organize-Direct-Control.

The traditional approach tries to keep the lid on problems; the total quality mindset seeks to lift the lid and deal with them. The one is comfortable with the status quo; the other wants change. The first is inward-looking; the second is outward-looking. One is reactive; the other is proactive. In short, the Lead-Empower-Assess-Partner approach is allowing the leading-edge organizations to do a better job, to LEAP ahead in their quest for a better tomorrow.

We've seen, to this point, how TQM is redefining "management." But there is another companion term which is also being redefined: it's "leadership."

If you go back to that same group of executives, managers or supervisors and ask them to

define leadership, they'll say—after a long pause, because this is a more nebulous concept than management—something like, "Leadership is what those at the top of the organization do to make things happen."

But if you ask people in total quality organizations what they think, the first thing they'll say is that leadership doesn't—and shouldn't—happen only at the top. The next thing they'll say is something like: "Leadership is fundamentally about influencing the behavior of people, so the organization can improve its performance."

And how is the behavior of people being influenced in total quality organizations? Again, observation of what's happening with real people, in real plants and offices, is very revealing. Leaders at the top, middle and bottom of total quality organizations are using—often subconsciously—a *process* to provide direction and inspire action. This process is how they go about *applying* the Lead-Empower-Assess-Partner mindset.

First, they *articulate what they want to happen.* That is, they lead the development and communication of the organization's vision, values, strategies and goals. They also demonstrate this in their daily actions by "walking the talk."

Next, they *organize how it should be done.* This involves initiating the assessment, infrastructure, planning, key measures and implementation of the organization's total quality effort. And, it involves providing resources for education and training, as well as the tools, equipment and technology that will be needed.

And, they *empower others to make it happen,* by enabling problem-solving and decision-making, by encouraging teams, process improvement, a facilitator-coach management style, and information-sharing. They also help remove the barriers that get in the way of top performance.

And, they *monitor, acknowledge and formalize* the improvements. This involves evaluating progress, recognizing and rewarding results, and aligning policies, systems and practices with the vision, values and goals.

As you can imagine, doing these things takes a fair amount of time. How much time? During my interviews in those 70-plus organizations, I've routinely asked the managers what percentage of time they spend on such improvement activities. Not one said less than 25%; most answered: 25% to 50%. And when I've asked them how, with so many on-going things to do, they found the time, the usual response was something like: "I've empowered others to do some of my routine work. It's all a matter of priorities."

There it is, again, I'd think. *Another manager-leader: 75% of the time a manager; 25% a leader.*

Which is what Harvard Business School professor, John Cotter, has been saying. He argues that any one person can be both manager and leader. We need manager-leaders to run our organizations, at all levels, he asserts.

There you have it. In the leading-edge organizations which are building total quality cultures, we find that traditional managers are becoming manager-leaders. They're giving up their Plan-Organize-Direct-Control mindset, and are using a Lead-Empower-Assess-Partner approach. And they're using a leadership process to provide direction and to inspire those who report to them.

Remember what Frank Katkaveck of Abbott-Ashland said? "We want to become a world-class manufacturer...Our job as managers is to provide leadership, not dictate, and to get rid of the roadblocks so people can do their jobs well." So, forget about leadership *versus* manage-

ment. They are not contradictory. Real people, in real plants and offices, are doing both.

It's just a matter of mindset...and how you use your time.

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B2 Transforming the Management Team

The leader's role in creating a world class organization is to "act" in significantly different ways. A major success factor is the leader's ability to foster the desired leadership style in the management team. Two organizations actively engaged in this change process will discuss the lessons learned.

Jeffrey E. Grant, Vice President and Group President, Industrial Electronics Group, AND **Dr. Robert G. Williams**, Director, Employee Research, Education and Development, Hughes Aircraft Company, **"Driving Transformational Leadership at Hughes Aircraft."**

Robert G. Minor, President, Rockwell Space Systems Division, **"Moving from Managing to Leading an Empowered Work Force."**

DRIVING TRANSFORMATIONAL LEADERSHIP AT HUGHES AIRCRAFT

PANEL: TRANSFORMING THE MANAGEMENT TEAM

ROBERT G. WILLIAMS

DIRECTOR, EMPLOYEE RESEARCH, EDUCATION & DEVELOPMENT

OCTOBER 20, 1992

OUTLINE

HUGHES

- CONTEXT
- PROGRAMS
- EXPERIENCE

BUSINESS CONTEXT

HUGHES

- CHANGE IS A CONSTANT
 - DOD BUDGET
 - COMMERCIAL MARKET
 - COMPETITION
- NEW HUGHES
- CRITICAL ROLE OF LEADERSHIP

LEADERSHIP DEVELOPMENT THRUSTS

HUGHES

- THE CHAIRMAN'S PROGRAM
- cmi LEADERSHIP TRAINING

THE TRANSFORMATION OF MANAGERS INTO A LEADERSHIP TEAM

Michele C. Mumford, Strategic Planning & Systems Development
Hughes Aircraft Company, Surface Ship Systems Division

OBJECTIVE

The purpose of this paper is to share the experiences of a group of managers within a division at a major aerospace/defense company as they became a cross functional leadership team. The problem facing this group of managers was achieving aggressive sales and earnings commitments on complex, high change equipment. It was recognized that many functions contributed to the problems and that resolution was interdependent. This paper tells the story of how these managers resolved organizational conflicts, learned to discuss the 'undiscussable', and committed to a joint effort to achieve enterprise goals. It describes the production problem resolution process adopted by the division as well as the human factors (time commitment, trust of peers, empowerment) required for success of that process.

BACKGROUND

The problem facing the organization was achieving the production sales and earnings commitments on a major multi-year contract. The enterprise produces complex systems for the Navy. Typically, there is a high design change rate for new designs moving into production and as older designs are brought up to current technology; much of the material has long lead times; and often contract turn on is delayed due to government funding issues.

Organizational finger pointing was often employed to place blame. The goal seemed to be find someone to blame rather than work jointly to correct the problem. Accusations seems to migrate from function to function, depending on the nature of the problem. Fire fighting became the norm without the time to look ahead to potential problems. Even employing concurrent engineering methods for new equipment did not seem to alleviate all of the production problems.

Problems were not resolved in time to support sales commitments. No process was in place to support the production problem resolution process which insured the identification and resolution of the problems.

The solution to this problem evolved over a two year time period. Each technique would offer marginal improvement which often reverted back to the norm, as no process was institutionalized to insure continuous improvement.

Phase 1: Sales teams

A team was defined and a leader named who was accountable for the sales commitment for certain equipment. Lessons learned were that the leader was given this task as an additional assignment to normal duties and, although accountable, was

not given the authority to bring resources to bear on the problems. The weekly meetings quickly became status meetings, never addressing the problems.

Phase 2: "Honcho's"
Selected upper level managers were assigned to each product and became responsible for its sales. Lessons learned during this phase were that functional area managers gained a high appreciation for production problems. The adopted mode was fire fighting in nature, fixing problems without having the time to determine root cause. Therefore, although problems were now being addressed, no process changes were made so the fires kept on erupting.

Phase 3: Focal Teams
During the above phases, a project improvement team was formed to address the specific problem of engineering support of the production line. This team utilized a strong problem resolution process based on the Joiner® Team model. They developed a production problem resolution process which defined a cross functional team of people (focal team) to support the production cell. This process was not isolated to engineering support but encompassed any problem which impacted production. The make up of this team consisted of every function needed to resolve production issues: production supervisor, cell leader, materiel rep, engineering rep, quality, test, program management. The mission of this team was "to proactively manage and reduce production problem activity to optimally support cells in meeting their quality, cost and sales objectives." A complete mission statement can be found in the appendix. To prove out the concept, a pilot focal team was defined and their progress was monitored by the team.

The next step was to gain management support and buy in of the focal team concept as each functional manager needed to dedicate manpower to support the focal team. The buy in was not automatic as there were some cultural and accountability issues raised by the managers. The still-in-place Honchos and functional department managers took on the task of addressing the implementation of focal teams. This task grew to include how focal teams should be managed and who should manage them if we were to adopt them.

THE "COMING TOGETHER": DEVELOPING THE OVERSITE TEAM

What appeared to be a simple task of adopting a team's proposed solution began to uncover some major organizational and cultural issues within the division. Accountability became the biggest stumbling block. This is a natural impediment to implementing team management: there is no longer one organization or one person accountable (or to blame) for the overall success or failure. The major issue revolved around the fact that no one organization wanted accountability for those things outside their span of control nor did they want to give their control to any other organization. Production requires the support of most of the functions within the division. The traditional organization structure defined the managers of these functions as peers. Therefore the problem became who should be accountable for the overall sales of the division when the results were dependent on multiple organizations.

The group used a facilitator who employed a series of tools to flush out all of the issues and concerns. The first step was to define the things that needed to be done. The following list was generated based on the goal of "*DO WHATEVER IS NEEDED TO GET THE JOB DONE TO GET QUALITY EQUIPMENT OUT THE DOOR*".

OVERSEE PROBLEM RESOLUTION
-Set priorities and bring influence to get things done
-Communicate & coordinate plan of action to solve problems
-Facilitate
-Resolve issues as they arise
-Catalyst to energize the team and the organization to resolve problems

IDENTIFY/COORDINATE RESOURCES - MANPOWER, FUNDING, HARDWARE
-Need to manage diverse work force, divided among many organizations which have their own goals
-Break down barriers
-Muster up resources
-Provide cell support
-Authority to energize resources needed to fix problems
-Secure organizational priorities through oversight when needed

DELEGATE PROBLEM OWNERSHIP
-Focused set of experts to solve problems

TRACK PRODUCTION PLAN TO MINIMIZE IMPACT OF PERTINENT PROBLEMS TO PRODUCTION SCHEDULE
-Revolve activities around schedule and delivery
-Set production goals in small enough bites, set targets and develop recovery plans when not met. Provide status

SET INTRA-CELL PRIORITIES AND NEGOTIATE INTER-CELL PRIORITIES
-Set production goals in small enough bites, set targets and develop recovery plans when not met. Provide status

COORDINATE WITH SUPPLIERS

DEVELOP WORK AROUND PLANS (INTERIM SOLUTIONS)

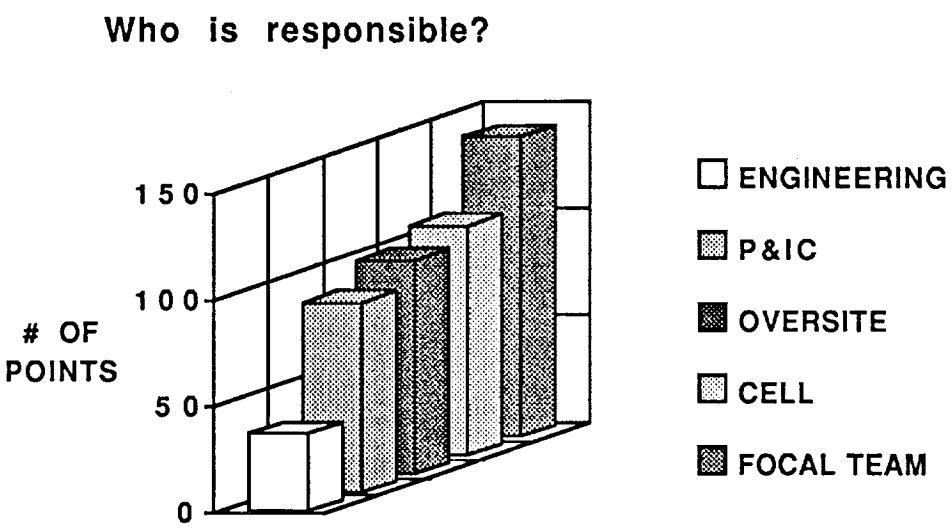
MAINTAIN VISIBILITY OF TOTAL PROCESS
-Communicate
-Provide a focus and a forum
-Get management attention when needed
-Document the process

DETERMINE ROOT CAUSES AND DEVELOP LONG TERM SOLUTIONS TO PREVENT RE-OCCURRENCE

The next step was to categorize the things to be done by functional area or team to understand overlapping roles and responsibilities. The functions were defined as the cell (production assembly work cell), the Production and Inventory Control funtion (P&IC), the engineering function (Eng), the focal team (described above) or the oversite team (the group of managers). A matrix was utilized to define the level of responsibility of each function resulting in the following matrix:

ACTIVITIES DESCRIBED AS THE FOCAL TEAM MISSION	THE CELL	NEW P&IC STRUCTURE	NEW ENG STRUCUTRE	THE FOCAL TEAM	THE OVERSITE TEAM
Oversee	1	0	0	13	0
Identify resources	13	2	3	6	0
Coordinate resources	1	0	0	14	0
Delegate problem	5	1	0	12	4
Track prod plan	13	9	2	7	0
Set cell priorities	10	6	0	7	4
supplier	1	13	2	10	4
Develop work around	13	9	9	11	9
Coord work around	3	5	1	11	9
visibility of prob res process	4	4	1	11	0
visibility of prod process	14	12	0	0	0
develop long term sol	7	7	8	10	7
Coord long term sol	0	3	2	9	8
Instit process imprv	10	8	5	4	14
Tie Breaker	0	1	0	0	14
Resource Allocator	0	0	0	7	14
Sales	13	9	3	9	13
ALL	108	89	36	141	100

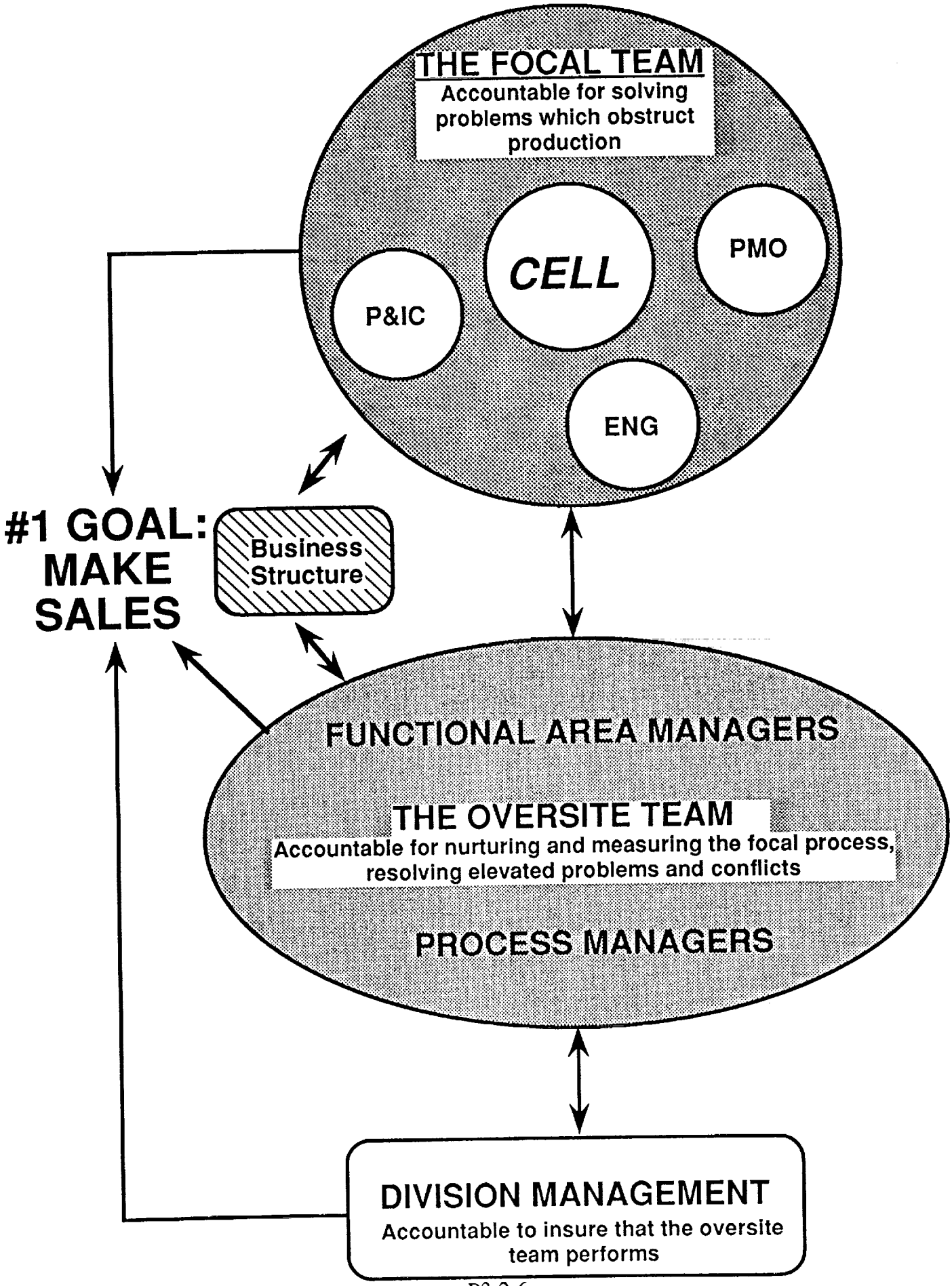
The following graph depicting the overlap of responsibilities was key to the buy in to the focal team concept.



This data led the team to consensus that many of the issues and concerns overlapped functions and needed resolution in a team setting. This data collection and analysis exercise allowed the group to adopt the focal team concept and agree upon the following principles:

- The focal process is essential
- The focal process will be executed by a focal team, consisting of the cell and dedicated support people from Engineering, Production & Inventory Control, and Program Management
- The focal team leader will emerge using oversite criteria and guidance
- Focal membership is a full time responsibility, with amount of time dedicated as required
- Product Operations accepts the responsibility for building the parts if there are no technical or material problems
- Functional areas are accountable for their functions
- Oversite team monitors the problem solving process, breaks barriers at group, division, all levels, provides trained resources as required, resolves conflicts between cells, sets enterprise goals, stays involved, understands impact of changes
- Oversite process must be institutionalized

The buy in to the focal process led directly to the need for a cross functional leadership process to move from individual department competition to team collaboration on problems. The team defined the oversite process and elected themselves and their process managers to the oversite team.


THE FOCAL TEAM
Accountable for solving problems which obstruct production
CELL
P&IC
PMO
ENG
#1 GOAL: MAKE SALES
Business Structure
FUNCTIONAL AREA MANAGERS
THE OVERSITE TEAM
Accountable for nurturing and measuring the focal process, resolving elevated problems and conflicts
PROCESS MANAGERS
DIVISION MANAGEMENT
Accountable to insure that the oversite team performs

THE IMPORTANCE OF A FACILITATOR

The 'coming together' process signified a culture change in the management team. Although the steps followed above look relatively simple, mountains of flip charts and hours of discussion were required to fully explore all of the concerns of the participants. A good indicator of the depth of discussion is that the focal process was presented to this group in October. Daily meetings lasting 1-3 hours were held and resolution and consensus were reached the following January. Culture and trust in others when it concerns our own destiny is difficult to achieve but is essential to the team leadership process.

A facilitator plays an important role in management team building. It is important to collect data and take an objective look so that conclusions can be drawn. In this case, the same data was analyzed in a variety of ways, always coming to the same conclusions. In the end, the 'emotional dissenters' had no other choice than to consensus on the focal process. Using established process tools led credibility to the exercises that were conducted and belief in the results.

IMPLEMENTATION

The oversite team sanctioned 6 focal teams to begin operation. They shared the focal team mission statement with them and guided them in the formation of their team. An agenda was set (found in the appendix) which asked the focal team to address the progress, issues and concerns and the team dynamics.

Administrative issues were resolved:

- 30 minutes was scheduled each morning to meet with each of the focal teams. If progress was good, focal teams were scheduled every other week.
- Team rules for oversite behavior were developed and documented.
- An action item board was placed in the meeting room so that oversite actions were documented and monitored and solutions reported back to the originating focal team.

Each meeting ended with an oversite team debrief of what went well, didn't go well and lessons learned. This debrief was essential during the implementation of this process so that oversite team behavior was monitored. The goal was to create a supportive environment so that critical problems could be discussed and assistance offered.

WHERE ARE WE NOW?

This group of managers has become a cross functional leadership team. Each is committed to the goals of the oversite team, attends meetings regularly, discusses the issues and concerns presented by the focal teams and spends time to understand the interdependencies of the organizations. Decisions are no longer made in a vacuum and everyone has the same level of understanding of production status.

The oversite process has been refined using formal feedback from the focal teams, information collected during a peer review appraisal process and a better understanding of the production problem resolution process. A 'close the loop' brainstorm has replaced meeting debriefs. This process leads the team in a discussion of what has been learned during the focal team reviews and how the sales forecasts, manpower and facilities plans must be modified to achieve customer satisfaction and the earnings goals.

The oversite team has recognized that they must meet an additional hour per week to 'close the loop' and to work on long term issues that are defined by the team. An example of a long term issue was to transfer lessons learned from one product development team (concurrent engineering) to the next. This issue expanded the charter of the oversite team to include the guiding of these product development teams not only to insure the transfer of lessons learned but to monitor the progress of another type of cross functional team.

SO, WHAT'S DIFFERENT?

A measurement of success for team management is to describe what is different:

- Barriers between departments are breaking down. Communication has improved between management and the employees, between focal teams and between managers.
- Sales are on track for all traditional equipment with the challenge now centered only on new products.
- Oversite team members conduct periodic peer reviews, giving formal feedback to each other as it pertains to their contributions to the oversite process.
- The management team is now available on a daily basis to anyone in the division who has a critical problem. The forum is open to all and the team members will alter their schedules to give time to the problem at hand.
- Action items outside the span of control of the focal teams are addressed by the oversite team. Because they are monitored on the action item board, issues and concerns are worked and resolved rather than lost.
- Trust among the members has grown. Issues are discussed inside of the oversite meeting and resolved. The 'undiscussables' such as behavior are brought to the surface and dealt with as needed.

CAN THIS CONCEPT BE APPLIED ELSEWHERE?

This concept can be applied in any environment where there is a need for a cross-functional management team. The criteria for success is the willingness of the management team to work together to resolve the differences confronting them. The key motivator in this case was survival. The aerospace and defense business is declining, the corporation is experiencing massive organizational change and our business base can only be maintained by our performance. Hence the motivating factor was survival. This organization was well versed in continuous improvement and participative management styles. The oversite/focal team process was an opportunity to put the these lessons into practice.

The lines of accountability and functional responsibility seem well defined in a traditional organization but in actuality the interdependency is what can make a manager succeed or fail. The management team must realize their interdepencies and be willing for the lines to blur and focus on a common goal. The rewards system often allows for functional sub-optimization without the overall goal of the organization being achieved. The team must be willing to change the criteria for reward (joint goals) in order to be successful.

Cross functional leadership teams will only be successful if the members are willing. No amount of upper management direction can force a team to function, the performance must be achieved by the dedication of the people on the team.

APPENDIX

FOCAL TEAM MISSION STATEMENT

Proactively manage and reduce production problem activity to optimally support cells in meeting their quality, cost and sales objectives.

GOALS FOR IMPROVEMENT

- Create a central point of responsibility and ownership for cell problems
- Reduce the cycle time to identify and implement unplanned product changes
- Define, enhance and document the problem solving process (lessons learned)
- Reduce the impact of things that negatively affect production
- Reduce production problem activities

SUGGESTED MEASUREMENTS

- Variance to MPSS
- Late to Start
- Key Operational Indicators that apply
- Document problem resolution cycle time: problem identification to problem solution to solution implementation

RESPONSIBILITIES OF THE FOCAL TEAM

- Oversee problem resolution
- Identify, coordinate and negotiate resources that are required to solve problems
- Delegate problem ownership
- Track production plan to minimize impact of pertinent problems to production schedule
- Document performance of problem resolution (team minutes)
- Develop work around & recovery plans (interim solutions)
- Determine root causes and develop long term plan to prevent recurrence.

DEFINITIONS

The Focal Team

A focused set of representatives from the Cell (build and test) and the organizations which normally provide support to the Cell. The team is designed to overlay the routine build and test structure of the cell with a focused set of experts in supporting disciplines who are responsible for:

- Proactively identifying or heading off any and all problems which will impact the production cell
- Rapid validation, solution strategy and solution implementation for problems identified which impact the cell

With this responsibility to resolve production impact problems, comes the authority to energize and request support organizations to supply high priority, timely resources in support of the problem resolution.

Each functional organization retains accountability for their function and gains the responsibility to designate through organizational definition, specific resources to support the focal process.

The Focal Team is not responsible for the routine, day to day administration, planning, resource management and statusing of Cell build or test activities.

The Focal Process
The focal process is a problem management & resolution process which insures that completed kits can be released to the floor on time and that the finished equipment is delivered to the customer per MPSS.

The Oversite Team

A set of managers representing all areas within the division that are required to support the focal process. Their role is to provide resources to and remove obstacles from the focal teams.

The Oversite Process
A process which the oversite team will use to insure that the focal teams/process are properly nurtured and are reaching their stated goals.

FOCAL TEAM - OVERSITE TEAM
WEEKLY STATUS AGENDA

HEALTH CHECK - METRICS

- VARIANCE TO MPSS: VARIANCE TO START, COMPLETES RECOVERY PLANS SHOULD BE INCLUDED TO SHOW HOW THE GAP BETWEEN PLAN AND ACTUAL WILL BE CLOSED
- STATUS OF ITEMS SCHEDULED FOR SALE THIS MONTH. WE ARE LOOKING TO THIS CHART TO BECOME A 'REAL TIME' AUTOPSY, IDENTIFYING THE ROOT CAUSES OF OBSTACLES. SUGGESTED FORMAT IS ATTACHED
- AUTOPSY IS REQUIRED ONLY FOR THOSE ITEMS PROJECTED TO 'SELL' THIS MONTH AND DID NOT DO SO

TEAM DYNAMICS

AN OPPORTUNITY TO DISCUSS THE FOCAL/OVERSITE PROCESSES. THE OVERSITE TEAM FEELS THAT EXPLORING THE PEOPLE ISSUES IS IMPORTANT TO THE SUCCESS OF THE FOCAL TEAM. WE STRONGLY SUGGEST THAT THE FOCAL TEAMS DEBRIEF AT LEAST 1 MEETING PER WEEK FOLLOWING THE WELL/NOT WELL/LESSONS LEARNED FORMAT. BRING THE RESULTS OF THAT DEBRIEF TO THE OVERSITE MEETING.

ACTION LOG OF PROBLEMS/ RECOVERY STEPS

EMPHASIS ON HOW PROBLEMS ARE BEING FIXED. HOW THEY AFFECT PRODUCTION SHOULD BE DISCUSSED AT REGULAR PRODUCTION MEETINGS. HIGHLIGHT SHOW STOPPERS OR PROBLEMS BEYOND THE POWER OF THE FOCAL TEAM. BE PREPARED TO ANSWER QUESTIONS SUCH AS 'HAVE YOU LOOKED AT.....?', ' HAVE YOU TRIED.....?'

SOME OF THE FOCAL TEAMS HAVE ADOPTED A LOG WHERE THEY KEEP A RUNNING LIST OF ISSUES AND ACTIVITIES. WE HAVE FOUND THIS EXTREMELY BENEFICIAL IN UNDERSTANDING THE PROBLEMS PLUS THE PROGRESS OF THE RESOLUTION OF THOSE PROBLEMS. WE STRONGLY ENCOURAGE EACH FOCAL TEAM TO ADOPT A LOG FORMAT,
AND A REVISIT OF ALL OPEN ACTIVITIES AT EACH MEETING.

RULES GOVERNING OUR BEHAVIOR

1. One meeting - be active listeners
2. Search for the problems, not for the guilty
3. Keep it positive - provide genuine praise and re-enforcement
4. Focus on problem solving process or the process that is causing the problem
5. Don't fix it here - watch how the team is fixing
 - Why can't team fix it
 - Determine next step / identify help and assign action(s)
6. Coach/mentor/teach problem resolution
7. Give team the time it needs (don't cut meeting short)
8. Constructive feedback (criticism) - work with team leader
9. Must continually tell them our expectations as they evolve - document them
10. Demonstrate professional courtesy and that we are a team
11. Be honest about what the team is doing
12. When we become actionee for focal team, we must be responsible
13. Don't give focal team too many rules

OUR GOAL: IMPROVE OUR BEHAVIOR SO THAT WE CAN ATTEND THEIR MEETINGS ON THE FLOOR

RULES FOR TEAM MECHANICS

1. Meet with a team a day
2. Quorum = 10
3. Replacements are not acceptable
4. Be on time, start on time, tardiness not acceptable
5. Mark calendar for known absences
6. No formal minutes but keep action log (white board)
7. When voting, all members have equal vote
8. Strive for consensus ("live with it")
9. Ensure "Responsible Empowerment"
 - No passive resistance
 - Actively support team decisions
 - Commitment
10. Facilitator required
11. Consider budget constraints before consensing on each solution. We need a budget deficit policy
12. Another meeting is not a valid excuse between 7:30 and 8:00
13. Stay on the agenda- recognize a filibuster
14. Each meeting will have a debrief of action log and well, not well, lessons learned

C Success Stories in the Quest for Excellence

This session will focus on actual case studies that demonstrate how the process of continuous improvement has been used in the quest for world class excellence. Presentations will provide hands-on documented successes as well as challenges, problems, and set-backs along the way.

CHAIRMAN'S PROGRAM

HUGHES

- YEAR-LONG PROGRAM
- ORGANIZED IN TEAMS
- BASED ON RESEARCH
- LEADERSHIP FEEDBACK
- LEADERSHIP MODEL
- TARGET- STRATEGIC ISSUES
- ACTION LEARNING - STRATEGIC PROJECTS

STRATEGIC DIRECTIONS

HUGHES

IDENTIFIED TO MEET THE CHALLENGES OF TODAY AND THE FUTURE

- STRENGHENING THE CORE BUSINESS
- NEW DIRECTIONS
- VALUING HUGHES PEOPLE

CHAIRMAN'S PROGRAM

HUGHES

IMPACT–

- FORUM FOR CEO
- DRIVES CHANGE INITIATIVES THROUGH LEARNING AND STRATEGIC PROJECTS - CMI LEADERSHIP, DIVERSITY, COMMUNICATION, INNOVATION, DIVERSIFICATION....
- FEEDBACK TO EXECUTIVES FROM CUSTOMERS OF THEIR LEADERSHIP
- COMMON LANGUAGE AND COMMUNICATION
- EXECUTIVE TEAMING ON STRATEGIC ISSUES
- FOCUS ON THE COMPANY

cmi LEADERSHIP

HUGHES

NEED TO PURSUE - A RESULT OF CHAIRMAN'S PROGRAM TEAM

INTEGRATED STRATEGY REQUIRED TO GET ALL LEADERSHIP ON BOARD

- TRAINING
- COMMUNICATIONS
- MEASUREMENT
- REWARDS

cmi DEFINITION

HUGHES

THE COMMITMENT TO
CONTINUOUSLY IMPROVE
USING A
CUSTOMER AND PROCESS
FOCUS

cmi LEADERSHIP TRAINING

HUGHES

- TARGET - 4000 MANAGERS
- CASCADED TRAINING
- LEADERSHIP FEEDBACK
- PROGRAM CONTENT
- ACTION PLANS

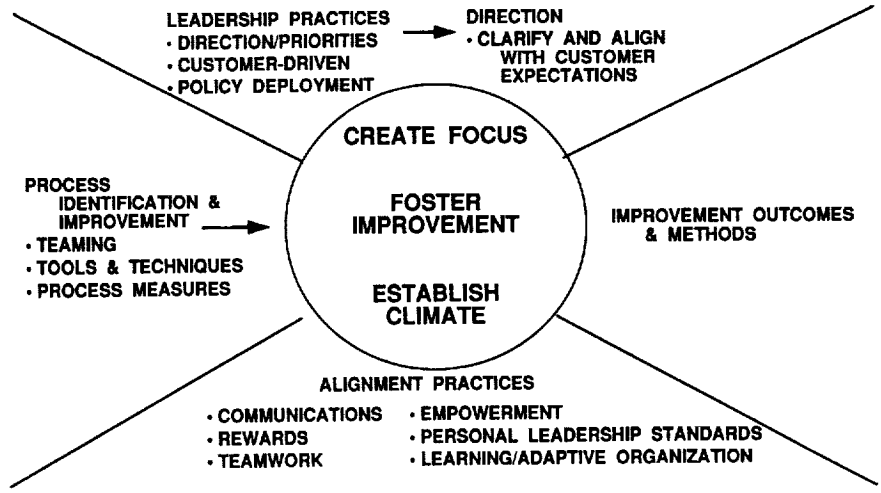
WHY *CASCADED* TRAINING?

HUGHES

- PROVEN TECHNIQUE
- DEMONSTRATES MANAGEMENT COMMITMENT
- BUILDS ORGANIZATIONAL ALIGNMENT
- INSTRUCTOR CREDIBILITY AND ENHANCES APPLICABILITY OF CONTENT
- FOSTERS ORGANIZATIONAL COACHING PROCESS

COURSE CONCEPT

HUGHES



VISION FOR THE NEW HUGHES

LEADERSHIP

that creates
A WORKING ENVIRONMENT
which facilitates
TRUST AND TEAMWORK
and results in
CONTINUOUS MEASURABLE IMPROVEMENT
to meet
CUSTOMER EXPECTATIONS

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Moving From Managing To Leading An Empowered Work Force

Robert G. Minor
President
Rockwell International
Space Systems Division

Abstract

Few organizations can rival Rockwell International's Space System Division (SSD) and its rich history of technological success. From X-15 to Shuttle we have been privileged to make significant contributions to the development of manned space flight. But the environments that gave birth to those wonderful successes, like the products they spawned, are changed forever. New forces now shape our agenda. The national economy is struggling, our defense posture has changed, competition is global, and employment is fragile.

Rigid systems and autocratic leadership were no longer effective in this changing world. No longer could we rely on the minds and hearts of a few managers. Our survival required new ways of thinking and new ways of doing business. Our change strategy required the participation and high involvement of all employees in the challenge of knowing and serving our customers better than anyone else.

To achieve that objective required a major change in thinking and behavior, first from management and then everyone in the organization. The success of this change process requires: 1) a commitment to change, 2) a strategy to make it happen, and 3) an education and training curriculum to provide the new thinking and tools to sustain the change process in a total quality environment.

Management had to change its mindset from dictating isolated "fixes", to creating an environment where employees, empowered within their job responsibilities, identify areas for improvement, and find innovative, integrated solutions on a continuous basis.

A New Way of Doing Business

J. Carlzon, President of SAS Airlines, once remarked, "We did not seek to be 1000% better at anything. We seek to be 1% better at 1000 things." Tom Peters, in his videotape, "A Passion for Excellence: The Obsessive Pursuit of a Dream," observes that a paradox exists. While businesses claim, in all earnestness, that they want to be the best in all things, they recognize that excellence comes from an obsession with the everyday, trivial, mundane aspects of our businesses. At SSD, we started by trying to be 1000% better at 1000 things, which we still believe can be done, but not without changing the management's mindset.

In 1988, as part of our change effort, SSD surveyed each of its employees at all five of its national sites. The survey queried, "What is the division's greatest opportunity for improvement?" "Bureaucracy" was a disheartening, though not surprising response for a large, tradition-rich division whose integrated technologies produce one of the world's most complex systems, the Space Shuttle Orbiter. Responses such as "bureaucracy" developed concrete meaning as SSD conducted post-survey focus groups to review and improve our systems. We

developed a mission statement, identified key issues and processes to be worked, and streamlined our policies and procedures. In 1990 the survey was repeated; we were confident that our efforts would be reflected in the numerical results. However, the results stayed relatively the same.

At that juncture, we developed a vision, identified our core competencies, and strengthened our commitment to enable and grow our cross-functional work teams. At the core of our thrust were two elements; process improvement and organizational change. Another key change was to develop a more rigorous and structured approach to integrate these elements.

Fixing the isolated problems encountered to address survey concerns did not change the way we do business. It was a hit-and-miss treatment that addressed the symptoms, not the diseases. In 1990 we were successful at capturing the George M. Low Trophy, NASA's Quality and Excellence Award. However, in today's world of diverse programs, technologies and customers this achievement marked but a milestone in our change process. While NASA recognized our achievements in quality and excellence, we realized we had more work to do. Measurable and lasting change would require a holistic approach, embracing a methodology, a strategy, for change.

We refocused our direction in late 1991. All executive management has been devoting at least 20% of their time since then to change the way we do business. As president, I chair our continuous improvement executive steering committee—which meets weekly. All senior executives of functions or programs also lead steering committees within their organization, and we established strategic cross-functional teams to address improvement of our major business systems.

Model For Change

To further refine our change strategy, we reviewed our current practices and training, other companies' change efforts, and numerous consultants' recommendations. As previously mentioned, our approach had been fragmented. We found that other companies, and the recommendations of most consultants, focused on mass skills training for workers. We reviewed many models for change, but a model from New Realities, Inc., was complete and met our requirements. Shown below in Table 1, it begins with preparing the leadership for change, and eventually led to the building of new systems and disciplines.

Change Model
1) Prepare the Leadership Team 2) Create Awareness and Commitment 3) Refocus the Work Activities 4) Enhance Skills and Knowledge 5) Build New Systems and Disciplines 6) Renew the Energy

Table 1

"Going where the energy is" has been a successful change strategy. We attempted to meet one-on-one with the leaders who were most interested and motivated to transition to an integrated continuous improvement effort.. Our objectives in the several months of face-to-face "selling" were to emphasize that change requires time, and that success demands that management "walk-the-talk," that they apply deliberate, concentrated effort.

Training To Reflect The Change Model

Prior to 1991, SSD's management training was tools-oriented or non-applied ideology. In our training classes, we taught employees to approach problems with structure and methodology, yet we were not doing the same in approaching our task of continuous improvement education and training. SSD's curriculum now reflects the model for total quality leadership. The table below shows how the education and training activities are linked to the change process model:

Change Process	Educational & Training Activities
1. Prepare the Leadership Team	One-on-one meetings
2. Create Awareness & Commitment	Prepare the Leadership Team Workshop
3. Refocus the Work Activities	Empowering the Work Force Principle-Based Leadership
4. Enhance Skills & Knowledge	Team Building, Continuous Process Improvement, Team Facilitation, Statistical Process Control, Quality Function Deployment, Design for Competitiveness, Systems Engineering, Computer Aided Systems Engineering Tool Set
5. Build New Systems and Disciplines	The work of teams attending training together
6. Renew the Energy	Progress reviews and celebrating successes

Table 2

The courses are designed for participants to attend education and training courses with their work teams. When a team has attended together, the results have been significant; when we have had to deviate from the process, our experience was that each time we deviated the results were significantly reduced. Common objectives for these programs include building each team's rapport, doing the team's work in class, and educating the team so that they can be self-facilitating. As the model in Figure 1 suggests, the curriculum begins with general education, and concludes with specific tools training.

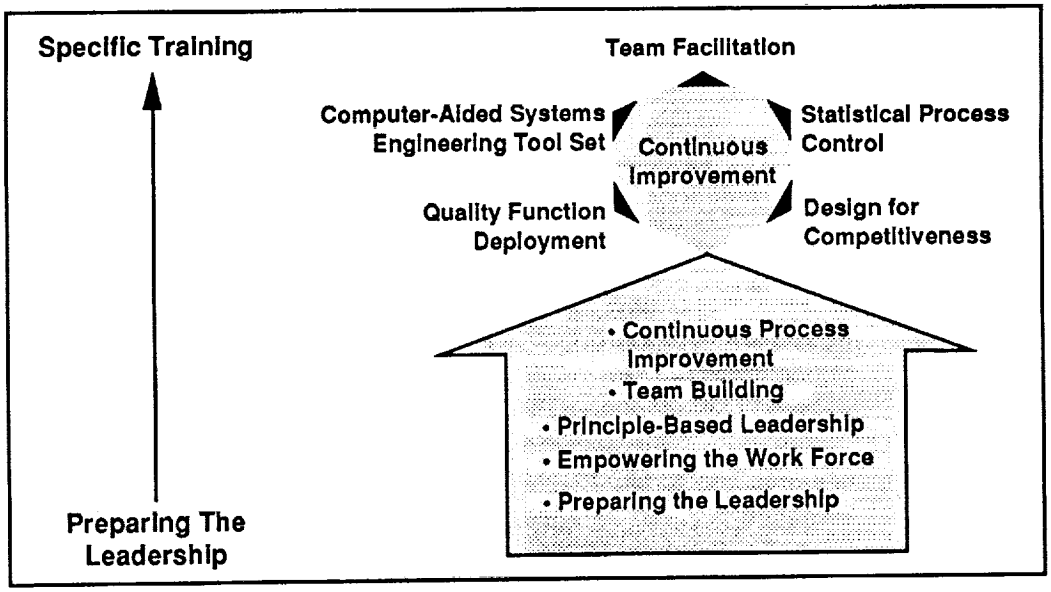


Figure 1

The curriculum begins with *Preparing the Leadership* to develop management's awareness and commitment to the transition process. If management skipped this course, we observed that the learning and commitment to change were not as pronounced in the next course, when management attended with their employees.

We firmly believed that these education courses must touch as many employees as possible, to energize and prepare employees for the eventual team environment. Over 1700 of our employees have attended the next course, *Empowering the Work Force.* The program demonstrates "how" a team environment is the most productive and fun way to work. This highly experiential program moves from the conceptual to direct application. Top executives kick-off each session, and return at the conclusion to respond to the questions and concerns raised by the participants.

The division's management, beginning with the top executives, continued to support continuous improvement education by attending *Principle-Based Leadership* . It was a program developed in conjunction with Covey & Associates, and based on Stephen Covey's book, Principle-Centered Leadership. The program advocates that in order for a person to be effective, he or she must operate around consistent and appropriate principles. Living by these principles creates an empowered environment for the participants and for the teams. Furthermore, *Principle-Based Leadership* provides a leadership assessment tool, which all executives and management completed. Each participant distributed questionnaires on his or her leadership style. The combined responses from the participant, his/her superior, direct reports, and peers, creates a baseline for further improvement and growth. All management attending the course will complete this assessment process.

Team Building introduces participants to the structure and function of work teams, and provides the necessary skills to begin working effectively in teams. Ideally, participants attend in work teams chartered with a specific task. Then, over 50% of the sixteen class-hours can be dedicated to the team's specific work. Participants report that their first meetings following the class are exceptionally productive.

After completing the previous courses, the employees will understand that personal commitment and teamwork skills are necessary to succeed in a total quality environment. This *Continuous Process Improvement* course overviews the specific skills, such as flowcharting and developing Pareto diagrams, that are needed to improve processes. As in Team Building, participants should attend the class in intact work teams with a project or process targeted for improvement.

The second half of the curriculum develops the success tool kit for participants. Whereas all employees, regardless of job, complete the first five courses, employees are selectively trained in the skills courses: *Team Facilitation, Statistical Process Control, Quality Function Deployment, Design for Competitiveness,* and *Computer-Aided Systems Engineering Tool Set.*

Furthermore, 15 volumes entitled, "Team Work Skills," a set of tools to improve how people learn and work in teams, is available to enable teams to self-facilitate in real-time. This material is designed to be self-taught by team leaders or members. A team can take a volume on a specific team skill, such as " Getting Started " or "Facilitating Group Process," and teach itself these skills on the job. Each volume contains a leader's manual, a participant's workbook, plus overhead transparencies and is structured in 50 minute OJT skill building modules. Moreover, each lesson can be fully customized to be team or program specific (i.e., IPT's , PDT's etc.) with minimal effort.

Building and Sustaining Momentum

As we entered 1992, our training curriculum was being refined and the division was being reshaped by the external business environment. Our division objective was to know and serve our customer better than anyone else. As president, I directed a major cost and rate reduction initiative to improve our competitive posture and better meet our customer's expectations. We reduced our operating costs by 30%. New division-level goals were established: To reduce the cost of doing business by 30% in 1992, and by 10% each year thereafter; to reduce the cycle time of our processes by 50%; to achieve 100% involvement of our work force; and to continue to provide customer satisfaction.

Our focus on team activity was expanded. By May of 1992 we identified more than 150 continuous improvement teams operating within the division. By July of 1992, more than 1700 employees had attended the *Empowering the Work Force* workshop. Eight major program teams with executive and functional management comprised the core of that number. As a result of the education, awareness and heightened commitment, teams are developing new systems where none had previously existed. Increasingly, employees who have been through the training are utilizing the concepts and principles in their natural work environment.

Preliminary results show noticeable and measurable difference in executive behavior as well as significant improvement in processes and cost reductions. For example:

- One program realized a significant cost savings and cycle-time reduction by the teaming companies suggesting their customer "walk the wall" with them and use the Program Briefing as " the Proposal." This simple example of the results of improved team working relationships for real-time collaboration and problem-solving enabled typically 6 months of proposal work to be completed in 2 hours. All participants walked away with red-lined final copy and all participants heard the same thing at the same time.

- One team of non-management employees led the integration of the administrative processes of three departments, effectively reducing systems by two-thirds.

- In 1991, a dedicated, cross-functional team was formed and tasked through the contract to reduce system integration costs by 25% over four years. To date, the team has realized savings in excess of the original goal, and has expanded to involve 20 project teams who apply continuous improvement methods daily to contract tasks.

Conclusion

By following a clear strategy for change, based on firm management commitment and by bolstering that strategy and commitment with a comprehensive education and training program, we have shifted the burden for continuous improvement from a few management and placed it in the heads, hearts and hands of all our employees. This new way of doing business has allowed more areas for improvement to be addressed and more energy and creativity for sustaining our commitment...to being the premier NASA producer in manned and unmanned space flight...by engaging the entire work force in knowing and serving our customer better than anyone else.

OMIT

B3 Leadership Success Stories

Success stories with demonstrated results highlighting leadership style and how it can make a difference in implementing Total Quality Management throughout an organization.

Paul B. Smith, Vice President and General Manager, Tactical Systems Division, Rockwell International Corporation, **"Developing a High Commitment Organization."**

Michele C. Mumford, Head, Strategic Planning and Systems Development, Materiel Operations, Surface Ship Systems Division, Hughes Aircraft Company, **"The Transformation of Managers into a Leadership Team."**

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Developing a High Commitment Organization

Paul B. Smith, Vice President and General Manager
Tactical Systems Division, Rockwell International

What do we mean by high commitment organization? High commitment means trust. It means relying on the character, ability, and strength of the organization. We have difficulty trusting close associates much less an entire organization. Yet in our highly complex businesses of today, unless we develop employee commitment, we are almost doomed to failure, stalled by the mass of our outdated and ineffective infrastructures while attempting to compete in a lean market place. I am going to share with you what Rockwell's Tactical Systems Division (TSD) has done in developing a high commitment organization.

MANAGEMENT TEAM

The management team at TSD, from an organization chart viewpoint, is a traditional matrix organization with program offices and functional management. The uniqueness of the TSD organization is two change agents reporting to the General Manager. These two positions, Director of Organizational Excellence and Director of Total Quality Systems, along with the General Manager, form a troika that is committed to assuring the implementation of a high commitment, high performance work culture. The Organizational Excellence Director is a senior organizational development specialist concerned with improving organization behavior and structure. The Total Quality Systems Director is a senior technical specialist concerned with improving processes. This structure not only sends a powerful message to the organization that we are serious about change, but also provides the clout to assure its implementation.

NEED FOR CHANGE

Why do organizations want to change? The answer is they don't. Michael Porter, in a Harvard Business Review article, stated that "Change is an unnatural act, particularly in successful companies; powerful forces are at work to avoid it at all costs."

Unfortunately in our society, whether it be in our personal life or our businesses, it generally takes a significant emotional event to produce change. Eating or smoking habits only change after serious medical problems occur. Corporations only change after market loss or unacceptable performance.

In our case poor **performance** and unhappy **customers** were the result of our inability to change by properly addressing many adverse signals.

Performance indicators in the early 1980's began a death spiral. Profit, hardware delivery, data delivery, scrap, rework, yield, indirect costs, direct costs, you name it, it was unacceptable. The solution, of course, was to change management and add people which, as we all know, simply exacerbates the situation.

Customers, both corporate and contract, were becoming very impatient. As a result, we entertained a myriad of boarding parties all too eager to "help" us out of our dilemma. Our valuable resources were consumed creating status reports, get well plans, recovery schedules, etc.

CHANGE EFFORTS CONFUSED

With all of the "help" came a plethora of advice from all of our customers. Everyone had a pet program or a silver bullet to lift us from the morass. Some suggested that we needed better inventory and work-in-process control so they recommended JIT methods. Others suggested we incorporate statistical management methods using the Deming philosophy and Statistical Process Control. Still others recommended we optimize our processes utilizing Designed Experiments. Our corporation suggested Gainsharing as a motivational tool and Organization Redesign to become more productive. We had a "program of the month."

TOTAL QUALITY SYSTEM MODEL

All of the suggestions had merit. The problem was how to effectively assimilate them into our infrastructure. As we pondered this, it became apparent that we needed a systems approach to change and that we needed a model to describe that system. Upon further evaluation, we recognized that all improvement methods tended to fall within three categories: (1) Change Processes; (2) Tracking and Measurement Processes; (3) Incentive and Reward Processes. We had to change the culture to effect real change. I will describe our culture change and the major elements of the above three categories.

CHANGING CULTURE

We identified four major elements to changing culture. First, understanding the concept of **Total Quality** within the organization - who is responsible for quality? Second, understanding about **customers** - who are they and what are their needs and expectations? Third, **management** understanding their role in a high commitment organization. Fourth, recognizing that **people** are our most important assets.

Total Quality is the premier concept in a high commitment organization. If every person in every discipline throughout the organization does not recognize their contribution to quality, then the chances of having a world class operation are nil. But what do we mean by quality? Simply put, quality in our organization means satisfying our customer, the person who receives our output.

Customers expect value. Corporate customers expect maximum return for their investment. Downstream customers expect outputs with minimum variability. Customer needs and expectations must be understood.

Management must understand their role in a high commitment organization. Dr. Deming and others explain quite clearly that at least 85% of our problems are in the system and less than 15% are under a worker's control. This translates to having a 15% leverage if you expect to get improvement through execution alone. Management must recognize this premise and the fact that they own the system.

Consequently, real change will only occur when we begin working on the system. Real change only occurs when you fundamentally change the way you do business and that is management's responsibility.

Another important concept our management team must grasp is that of commitment. Commitment (character, ability, trust) is not enough. We can have a committed management team who is sincerely "behind the employees all the way" when it comes to change, but what we need in addition to commitment is leadership.

Leadership at TSD does not mean that our management team is "behind their employees all the way." It means they are out in front leading the charge. For this reason, our entire training program was structured to train management first from the General Manager down. How can one lead without the training?

People are our most critical asset. They are the key to change. They are the ones closest to the work and most knowledgeable about the work. They must be trained in change processes and empowered to apply what they have learned to improve their systems. We have found that people are most effective when working in a team environment. The synergy of multidisciplined product and process teams and the results of these teams have exceeded our wildest expectations. The investment in the team process, including organizational structure transformation and training, has reaped exceptional returns. Many of our teams are self managed, taking on the responsibility that was traditionally supervision's. When teams feel ownership in their processes, are empowered to participate in decisions, and share in the results, they are a powerful force indeed. I cannot envision a high commitment organization without them.

CHANGE PROCESSES

As we begin to develop a culture that understands the need for change, we must provide a method to change. In our Total Quality Systems model, we call these our "Change Processes." Our Change Processes consist of two types. The first is **Organizational Excellence** which is the method for changing organizational systems, and the second is the **Value Improvement Process** which is the method for changing processes. Both processes utilize common tools such as data collection and analysis and problem solving, and both utilize multidisciplined teams.

The **Organizational Excellence Process** is what might be called our strategic change process. It deals with longer term, complex issues usually related to the organization's infrastructure. This process involves management and senior professionals. The Organizational Excellence process is based on a derivative of the McKinsey group's 7-S organizational systems model. In this process each of eight major elements of an organizational system such as business strategy, systems and procedures, management style, or rewards systems are considered in relationship

to each other. The process is designed to assure that all of the major elements are in alignment so they complement each other. This is done by visioning a future state of alignment for each element, evaluating the current state, and then developing actions to transition from current state to future state. This process helps assure a constancy of purpose for the organization.

The Value Improvement Process is our tactical change process. It deals with shorter term issues and involves all employees and the systems they are involved in from day to day. This process is based on a simple three step model. The three steps are to first understand the process, secondly characterize the process, and third simplify and improve. Every employee at Tactical Systems Division is familiar with this process and is trained in the tools necessary to implement it. The whole intent of process improvement is to simplify, simplify, simplify. We find that through this process we often simplify to the point of eliminating unnecessary and redundant tasks.

TRACKING AND MEASUREMENT

We now have established a culture that understands the need for change and provided change processes. We must now have a process to track and measure change. Three major elements for tracking and measuring change within the Division are identified. The first is our Annual Operating Plan which is our contract with the corporation and contains major business indicators and strategies. The second is a **Functional Support Plan** . The third is Gainsharing indicators which will be described in the section on incentives and rewards.

The Functional Support Plan (FSP) provides a means for employees to become stakeholders and business partners in the organization. In order for this to occur, they must be able to interpret their daily tasks in the context of our business commitments. In other words, we must have a means of flowing down the Annual Operating Plan to the lowest levels of the organization. The FSP is a process we have developed for doing this. It is a contract between the functions of the Division and the General Manager. In essence, it operationalizes the Annual Operating Plan at the levels in the organization that have to make it happen.

The FSP is structured in two parts. One is called **strategies** and the other, **report cards**.

Strategies are the plans that each function will accomplish in a given fiscal year that will support the requirements of the Division's business segments and the objectives of the Division. Strategies are developed at all levels of each function. Strategies are assessed by the department teams in reference to resource availability and typically 20-30 adopted for inclusion in an FSP. These strategies are formally planned with milestone charts identifying key actions and responsibilities. Generally each strategy is related to improving an existing process or adopting a new process. In either case, they are methods for improving the way we do business.

Report cards are metrics. They are the pulse of each function inasmuch as they measure the wellness of the function. The metrics and their associated targets are identified by the functions. Five major categories of metrics are developed: Cycle Time; Customer Satisfaction; Cost; Quality; Other.

The Functional Support Plan is constantly reviewed throughout the year. It is one of the main tools that stimulates continuous process improvement. Each month, the Director of each function reviews his function's FSP's. Each quarter the FSP is reviewed by the General Manager with the department heads. The FSP is also used by management to evaluate individual performance.

INCENTIVES AND REWARDS

The organization now understands the need for change, has processes for change, and is able to plan and track change effectively. But how do we sustain this culture and these processes? We must have an incentive and reward process that reinforces the organizational behavior and processes that result in high commitment. We have two major elements of incentive and rewards. One is a strong **recognition** program and the other is a **gainsharing** program.

Recognition is team based. Our most prestigious recognition is our Quality First Team award which recognizes a team effort that has utilized our change processes in bringing about significant improvement in the organization. One unique flavor of this recognition is that it is self nominating. Teams that feel they should be recognized nominate themselves by presenting a formal submittal and subsequently briefing that submittal to a peer selection committee. We have several individual recognitions, but these recognitions are heavily weighted on the individual's involvement in the team process. In addition, teams are encouraged to submit individuals for recognition.

Gainsharing is the reward process where we demonstrate that we are serious about total quality and a high commitment organization.

Many people erroneously equate gainsharing with profit sharing. As a matter of fact, the traditional perception of gainsharing is that of the corporation having to share its hard earned profits with employees.

To the contrary, we have true gainsharing. That is to say that only real gains above and beyond our plan are shared with the employees. In other words, unless we exceed commitment, there is no gain.

Gainsharing by its nature is not only a reward system but, it is also a measurement system. For the gainsharing program to have any meaning and provide any incentive, we must develop viable metrics at the lowest levels in the organization.

The gainsharing program is developed and administered by a team of employees, both management and non-management, representing the Division functions. This team has developed indicators that best reflect the employees contribution to the Annual Operating Plan. Typical indicators are Unquality Cost (scrap and rework), Hours per Unit, Average Assets, Product Yield, Cost Performance, and Indirect Budget Performance.

In order for gainsharing to be effective, these indicators must be flowed down to the lowest levels in the organization. Employee teams have made very innovative changes to our business systems to make this happen. On the production floor, for example, each employee knows his team's contribution to direct costs, indirect costs, scrap, rework, cycle time, schedule, etc. This creates real ownership in the business.

The gainsharing committee had agreed from the beginning that payout would be to all employees on an equal basis based on the overall Division performance. The results can only be characterized as outstanding. There has been real ownership evident in all aspects of the business. Employees are sensitive to Division expenditures because it affects their share of the gains. The program has been in place for five years. The first year, there was no payout. The second year $650 per employee; the third year $1200 per employee; the fourth year $901 per employee; and the jury is still out for this year.

OVERALL RESULTS

The overall results of our high commitment organization have been spectacular.

Using 1988 as a reference, our sales per employee have increased 137% with a constant product mix and level sales.

Our quality has improved dramatically. In 1990, our quality system was evaluated as the second best the Army Missile Command (MICOM) had evaluated. We were invited to apply for the Army's prestigious Contractor Performance Certification Program (CP)2 and qualified in a record five months, becoming only the third MICOM contractor to be certified.

Productivity in our HELLFIRE manufacturing also demonstrated significant improvement. Hours per missile were reduced 50%,missile production increased 260%, and scrap and rework were both down 74%.

SUMMARY

In summary, the systems approach for change has been very effective for Tactical Systems Division. When managers understand their role as leaders, when managing with data throughout the organization becomes a way of life, and when employees are empowered and motivated, a high commitment organization results.

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C1 Small Business Successes

This panel will focus on the success stories from smaller companies as they meet their unique challenges in implementing total quality programs in their search for growth and financial success.

Marcus B. Havican, Producer/Director, Taft Broadcasting Company, **"TQM Resource Constraints in the Small Business Environment, or, I Don't Have Time for Another TQM Meeting, I Have Work To Do."**

Raymond W. Smith, Contract Administrator/TQM Coordinator, Western Electrochemical Company, **"Employee Involvement: The WECCO Experience."**

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TQM Resource Constraints In The Small Business Environment or I Don't Have Time For Another TQM Meeting, I've Got Work To Do!

Marcus B. Havican, Producer/Director, Taft Broadcasting Company

Let me pose a scenario for you. Imagine a company with one thousand employees. Now let's say that this company employs two full-time quality experts with a three person support staff. That's five people to identify problem areas, coach TQM teams, work scheduling issues, produce materials, and provide TQM training, motivation, and recognition. In a thousand person company, five people equal one half of one per cent of that company's total manpower resource.

Now, let's say that you are a company of one hundred people. Those same five people would constitute five per cent of your entire staff. Not very realistic, is it?

The point here is that many small businesses don't have ANY full-time quality support. As a result, the implementation of a quality improvement program WILL have an impact on the existing staff. Resource constraints are inherent in the small business environment.

I would like to share a story with you about some of the growing pains that we experienced on one of five teams that were created when we kicked off a TQM program in the company where I work. We faced several difficulties that I'm sure others have also encountered; well-meaning management telling us what to do, and how and when to do it; lack of training; scheduling conflicts; overload; burnout; loss of enthusiasm.

I would like to ask you to keep a couple of things in mind as I explain what we tried to do to remedy these problems. First, none of us had ever tried anything like this before, and even though we experienced some frustration, we have come through it with an appreciation for the importance of a quality improvement program and the difference it can make. We believe in Total Quality Management. And second, we learned, through

hard-fought experience, that there ARE ways to get around the resource constraints inherent in the small business environment.

I was sitting in the back of the auditorium this morning, listening to Mr. Goldin and the other members of the Top Leadership Panel speak very eloquently about quality and productivity and TQM, when I realized what a big pond this is, what a small fish I am, and how very fortunate I am to be here swimming alongside the big fish.

As a matter of fact, I started to feel this way when I spoke to our panel manager, Mr. Lander, the first time, and let me tell you why. I was returning a call to his office, and a lady answered the phone, "Executive Office". Executive Office?!!??!! The feeling got even stronger after I received a draft of the conference schedule and saw who the other speakers were. I looked through the papers and saw page after page of Presidents, Vice Presidents, CEO's, Executive Directors, Senior Managers, Corporate Directors, and Chief Operating Officers. These are some experienced fish!

Now don't get me wrong; I'm just as happy as a tick on a dog to be here, and I'm very proud to have the opportunity to represent Taft Broadcasting and visit with you about our efforts at TQM, but keep in mind that I am just a line-level workerbee with a little less than one year's experience with Total Quality Management. The key words here are "line-level" and "experience".

OK, I have a question for you; How many of you came down to Houston for last year's conference? How many watched the broadcast on NASA Select? Well, if you happened to hear any of the presentations in the Main Assembly Hall, or listen to the keynote speakers during lunch, or perhaps attend the George Low Trophy presentation, you might have seen a few television types moving cameras around and giving funny hand signals. But if you watched the NASA Select broadcast, you saw the result of a great deal of teamwork and the efforts of many, many people.

As Mr. Lander mentioned is his introduction, I am a Producer/Director. I do television. I work for a company in Houston called Taft Broadcasting, which is the Television Support Services Contractor for the Johnson Space Center. Taft took over this contract in September, 1991, and is a relatively small company which employs 150 people, 98 of which work at the Johnson Space Center.

Last November, Taft Broadcasting and JSC's Image Sciences Division provided television support for the Eighth Annual NASA/Contractor's Conference on Quality and Productivity at the George R. Brown Convention Center down in Houston. The production was supported by members of several Taft departments, most notably Production, Operations, and Engineering. In fact, this conference was the first exposure of many of Taft's employees to the concept of Total Quality Management.

Well, I was fortunate enough to be able to act as the Floor Director at last year's conference. I say I was fortunate, and I really mean that, and for two reasons. It was at last year's conference that I met my fiancee. And I was fortunate enough to be on the floor of the Main Assembly Hall with a ringside seat during the opening session, when the first two speakers on the Top Leadership Panel opened my eyes to the exciting possibilities that Total Quality Management offers.

At 9:05 a.m., Admiral Truly introduced Dr. Bob Gower of Lyondell Petrochemical, who was in turn followed by Dean Arthur Taylor of Fordham University. The experience was incredible. In addition to being mesmerizing speakers, these gentlemen were talking about concepts that I found fascinating. Things like "top down" and "from the bottom up". Upper management soliciting opinions from the workers. Line-level people making suggestions and being given the power to implement changes. Two way communication.

As the conference progressed, many of the people on our crew became more and more enamored with the entire concept of TQM. When the conference was over, one my co-workers, Jim Hansen, and I went into one of our edit suites back at JSC and put together a TQM Highlights tape from footage of the conference. We made a couple of copies and passed them around informally. As we talked among ourselves, we thought, "Wouldn't it be great if we had something like this as a way to get some of our ideas implemented?"

Coincidentally, about a week later we received a memo from our project manager, John Culp, telling us that Taft, along with JSC's Image Sciences Division, was forming several TQM teams. There were to be five teams created within Taft, and each of the teams were tasked to look at ways of increasing the quality of our product and determine the best methods for improving customer satisfaction. One of these teams was to be called

the Video Production Department Process Improvement Team, and I had been selected to be the team leader.

The Production Department is a group within Taft that produces both scripted and live television programming. We produce training programs, image pieces, marketing tapes, and educational videos. We direct press conferences and cover special events. Our department consists of five Producer/Directors, a Production Team Leader, an audio specialist, one tech, two scriptwriters, two editors, and two graphic artists. Each of the Producer/Directors has from eight to ten active programs at any given time. Since we have such a small department, allocation of the writers, production team, artists, and equipment, as well as customer needs and availability, can create competition for resources and unpredictable scheduling for all departmental members.

Well, management had determined that the Production PIT would initially consist of six hand-picked members of our department, in addition to one representative from the ISD Television Group and Taft's Project Manager. The chosen ones were assembled in a conference room one fine November morning, and as we looked around at each other, brimming with enthusiasm and eager to begin, management dropped a bomb on our poor, unsuspecting heads.

Now keep in mind that the Production Department is already a rather high profile group, due to the nature of our business and the programming that we produce. But during that first meeting, we were informed that our group, out of all the others, had been pre-selected to be used as a sort of "pet project" to demonstrate how well TQM works in the Image Sciences Division.

We were to analyze the entire video production process, from concept through pre-production, shooting and editing, and review/approval/close-out, and then design and implement measurable process improvements. We were to create flowcharts and overheads, write reports, and communicate with the ISD TQM Steering Committee. Upon completion, we were to make a formal presentation to the Center Operations Director at JSC. We were told that we were to meet a specific number of times each week, and we were to follow a specific, definite schedule with hard deadlines and monthly milestones. Oh, and by the way, we had five months to complete the entire exercise.

We looked at each other blankly, hardly believing what we had just heard. The silence was deafening, broken finally by a couple of very audible gulps. What happened to all of that "from the bottom up" stuff? Five months? The entire production process? What about our regular jobs? Would there be time to work on our programs? Where do we begin? How do we get started? None of us had any idea, but we knew that the heat was on. In fact, the kettle was boiling and six little fish had just been dumped into the water. Little did we know at that time that the pressure had just begun.

Management "suggested" that we meet three times per week, for two hours at a time. I don't have to tell you what kind of impact that had on our department! As I mentioned a few moments ago, we have a small department with limited manpower resources. Coincidentally, about the same time that we were cranking up TQM, we were suddenly inundated with an extraordinary number of rush projects that had to be completed yesterday. Now this is typical of the television production business near the end of the year. First of all there is the holiday season, with special projects, year-end deadlines, and lots of little "Oh, by the way..." projects that suddenly pop up. As you can well imagine, scheduling meetings around personnel availability was a nightmare. So from the very beginning, we found that our team's attendance was averaging two to four people, not exactly conducive to productive meetings.

During our first few meetings, we struggled with the process itself. How does this TQM stuff work, anyway? And by the way, just exactly what IS a facilitator, and what is he supposed to do? We had no idea what we were doing, but we plunged right in and tried as best we could. At first, we made no progress at all. We became frustrated and confused. We would come out of these two hour marathons exhausted, feeling that we had accomplished nothing.

Since we were being held up as a model team, management naturally wanted to help us progress. As I mentioned earlier, we had two management representatives on our team, and they were the only team members who had had any experience with TQM. The problem was that they both had different approaches, further adding to our confusion. We discovered that when management was in the room, we would get caught up in the PROCESS of TQM. We were spending more time listening to management tell us HOW to do it than actually DOING it.

But when management was unable to attend our meetings, we would just wing it; we brainstormed in a non-linear fashion, talking about whatever came to mind. Everyone participated and contributed, we would actually make progress, and we would come out of the meetings mildly excited. Ideas were generated, and pre-school quality flow charts and analyses begun. We began to crawl.

We found though, that team members just didn't have time to attend on a consistent basis. Two or three members were doing most of the work. And just as we would begin to make a little headway, we were told that we were getting ahead of ourselves, and trying to do too much, and that we should stop what we were doing and start over.

Well, I don't have to tell you that motivation began to slip, people were avoiding meetings like the plague, the team was becoming more and more frustrated, and there was grumbling in the hallway. The general feeling was that we weren't really doing TQM, but we were going through an exercise to appease our management, so that they could say that they had implemented TQM within their corporate culture. Now don't misunderstand me, management's intentions were noble, and they truly were trying to act in the best interests of our customers, but our TQM team was still existing within a hierarchical environment. We were being told what to do and how to do it.

OK, so now you must be thinking to yourselves, "Gee, Marcus, if you guys screwed up so badly, what are you doing up there?" Well, believe it or not, we turned it around. And we were able to come up with several improvements to the way we were doing business. So how did we do it? Well, bear with me just a few seconds more.

First of all, remember that Taft had taken over this contract only a few months before, in September, and that we were, as a company, still feeling each other out. In addition, the management of the company that had this contract just prior to Taft would not listen to any suggestions or recommendations from their line level people, so as employees, we were gun-shy from the git-go.

Our NEW Project Manager had told us that he had an open door policy, and that he would listen to and support his employees. We decide to find out if he meant it.

We went to our management and laid our cards on the table. "This is just not working", we said. We have been given hard and fast deadlines to meet and we are under pressure to produce. None of us has ever had any type of formal TQM training, and we are getting conflicting information from multiple sources. No one has any time to meet because we all have such a tremendous work load, and as a result, only three or four people are actually involved in TQM. People are getting frustrated and burned out, no one is motivated, we are having trouble wading through the political problems of ownership. We have two sets of customers; NASA and the end users of our programs. Who do we try to satisfy first? (He hadn't exploded yet, and we were on a roll!) And most importantly, we can't make any progress if management is always in the room telling us that we are going about this all wrong. In fact , WE'RE MAD AS HELL AND WE AREN'T GOING TO TAKE IT ANY MORE!!! (Well, we didn't really say that last part, but Network is one of my favorite movies, and that was a good way to work in a little Paddy Chayevsky.) Now where was I? Oh yes, in Mr. Culp's office, trying to get fired.

Gulp. Had we gone too far? As I came slowly back to my senses, I began to remember just how lucky I was to have a job in these troubled economic times, that it had been a lifelong dream of mine to work in the Space Program, and that maybe it would be a better idea for us to just shut up and do what we were told. Then came a question that none of us were prepared to hear.

What do YOU think we should do?

We looked at each other. (Yes, again. We like to look at each other when we're in that blissful, stuperous state known as disbelief.) Did we hear him right? What do WE think? There were smiles all around.

Well, for beginners, how about getting some training for some of our people so we have someone from within our group to guide us? "OK, let's try to find some training and get some people signed up. Next?"

We would like to invite everyone in our department to join the team, so that if some of us are busy, and we always are, we would still have enough people to have productive meetings. We would also like to have the option of involving some of our co-workers

from other departments so that we could get some feedback on the areas where there is inter-departmental interaction. "Sounds like a great idea."

We would like to cut down on the frequency and duration of the meetings we are having. "Do it".

Then, finally, it was time to state the obvious. "Mr. Culp, we feel like we can make more effective and productive use of our time if we hold our meetings without a representative from management present. We find that when we begin to make progress on a topic, we are being told that we need to stop what we are doing because we are not going about it correctly. We are constantly deferring to management and we feel that this is impeding our progress."

Well, I figured that we had finally gone too far. There was no way he was going to allow THAT. "Sounds good to me. I'll work on that part and you call us if you need us."

Incredible. We were empowered. We danced a little jig, held our next meeting a few days later, and hit the ground running. In the meantime, NASA and management arranged for representatives from several of the TQM teams to attend facilitator training. These people came back fired up, and their enthusiasm was contagious. We cut back to one, one hour long meeting, scheduled at the same time each week. Over the course of the next couple of months, we <u>were</u> able to analyze the entire video production process, and come up with several improvements.

We proposed a short five to seven minute videotape to be given to our program requestors before the initial meeting with the Producer/Director and Scriptwriter, that would explain the video production process, what the requestor could expect during the various phases of production, what their role is during the production process, and how they could expedite the entire procedure. Management approved the idea and gave us a work order number. This tape is being worked on in an "as time permits" fashion.

The second product is a checklist for the scriptwriters and Producer/Directors to use <u>during</u> the initial meetings with our program requestors. This checklist has been

completed, approved, and implemented. It has cut down on the number of meetings necessary to get a project rolling, resulting in a savings of manhours at the beginning and end of the video production process. The checklist has enabled us to deliver a program that is closer to what the requestor expected, with fewer revisions and re-do's.

A third idea was the acquisition of new, compatible video and audio editing equipment. This new equipment has been purchased, and will allow us to produce higher quality product, using cutting-edge production technique, and save manhours during the post-production process.

So, we're rolling merrily along, all of our problems are solved, and we all lived happily ever after, right? Nope. There was still that little May 15th deadline, remember? Well, we went back to management, and they had, in the meantime, rescinded all schedules and deadlines for all of the Process Improvement Teams, company-wide. Except one. You guessed it; the Video Production Department Process Improvement Team.

We were coming down to the wire, but our production schedule was intensifying again. You see, in the springtime, a young requestor's fancies turn to video. There were several shows that had to be finished ASAP, and none of our team members were available to meet. We went several weeks without meeting, but The Presentation was looming. Management wanted documentation, reports, flow charts, the whole nine yards. The only problem was that there was no one available to do it.

As a result, as the team leader, the task ultimately fell to me. TQM began to dominate my workday, and then began creeping into my personal life. I found that I was spending nearly all of my time at work doing TQM. I took it home with me and worked on it at night. I was eating, sleeping, and breathing TQM. I found myself making decisions and doing things without the support of the group. I wasn't getting any of my regular work done. Instead of increasing my productivity, TQM was having the opposite effect. My numbers were dropping, but there was nothing I could do about it. My time management was a nightmare. I was so sick of TQM that I wanted to urp.

Well, to make a long story short, we met the deadline. But after all that work and blood and sweat and tears, it turned out that our "pet project" was not the one selected for the center-wide presentation.

So, what did we learn from all of this?

I suppose that the most important thing we learned is not to be intimidated or afraid to communicate with our management when we feel that something is wrong. We found that our opinions and ideas have value, and that someone is willing to listen.

Management learned that giving teams directives concerning projects and then setting schedules doesn't work. They recognized the need to allow teams to set their own agendas and schedules.

We learned that without some form of training, teams would just fumble and stumble along, wandering aimlessly, with no productivity. There is a great need to provide some sort of guidance, in the way of formal training, documents, or videotapes.

In contrast to a large company, which might have the luxury of a full time quality specialist, and perhaps even support staff, a small company must call on its' employees to function in multiple roles. As a result, we cut back on the number of meetings and increased the size of our group, even inviting members from other departments to join us.

We were caught up in the "proper" way to do TQM, and struggling between a formal versus informal management structure. Management had to step back, relinquish control, empower the team, and trust us to do the right thing.

As a result of low and inconsistent attendance, pressure from management, and impending deadlines, members' productivity declined. We are still trying to find a better way to distribute the load.

We are learning, however. There are still other issues that we are wrestling with; motivation, the problems associated with dealing with two sets of customers, both horizontal and vertical, and the challenge of keeping the team going. Those are a few of

the things that we hope to learn about at this conference. If any of you have any suggestions, please let me know.

Now, what's the point? Well, we learned from experience. (There is that word again.) Somehow, through brute force, we were able to muscle our way into the TQM process and develop what we felt were some innovative solutions to the questions of quality improvement and productivity that we uncovered within our department.

But along the way, we learned several valuable lessons about ourselves and the way to do TQM. After bulling our way through the first few months, we discovered that the process uncovered ideas that we <u>were</u> motivated about. We still have a way to go, and we are learning all the time, but we believe that through intelligent resource allocation, distribution, and management, small companies such as ours can successfully implement Total Quality Management.

All of the five original teams that were formed at Taft by management directive are still active. Three additional teams were created spontaneously by empowered employees who saw needs that they felt should be addressed. Four of the other teams have completed work on one project and have moved on to another.

We still argue about the "right" way to do things. We have learned, as a company, that TQM is not necessarily an "offline" project that drags us <u>away</u> from our work, but a way to integrate a process of continuous improvement <u>into</u> our work. There is nothing that we do for TQM that cannot be made a part of our daily routine.

As the line between TQM and our routine work process fades, quality improvement is blending into the planning, execution, measurement, evaluation, communication, and integration of our regular activities. Soon we may think of Total Quality Management not as some "extra" task to please management, but as a tool that is necessary to complete every task we start.

I truly appreciate the patience that you all have shown this little fish as I've splashed around in the TQM pond today, yammering on. I'm really honored to be able to visit with you , and I'm looking forward to absorbing all that I can here at this conference. I

hope to have the opportunity to talk to a few of those Presidents and CEO's and pick their brains so that I can learn from their experience.

OK, I know that it's time for me to sit down, but before I do, remember what I said back at the beginning of this long-winded story? When I was talking about being a TQM rookie, with no previous experience?

I would like to leave you with a quote whose author I cannot identify. I CAN, however, give credit to the man who told it to me. His name is Ab Jackson. Abner. What a great southern name, don't you think?

Well, one morning last June, during a coffee break at a seminar in a Houston hotel ballroom, Ab Jackson put in all into perspective for me. He looked me straight in the eye and said;

"Experience is the comb that life leaves you when you've lost all your hair".

Then he smiled.

Thank you for sharing your time with me.

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Employee Involvement
The *WECCO* Experience

Raymond W. Smith, Contract Administrator, *WECCO*

About *WECCO*

The Western Electrochemical Company (***WECCO***) is a small business located in the desert, approximately 18 miles west of Cedar City, Utah. We employ 150 people in a $93,000,000 production facility that operates twenty four hours a day, seven days a week. As can be implied from our name, we use an electrochemical process to produce Ammonium Perchlorate ($NaClO_4$), the oxidizer in solid rocket fuel. NaCl (common salt) is oxidized to $NaClO_3$ and then further oxidized to $NaClO_4$ in our Cell House. The Cell House contains 8,000 electrolytic cells, 4,800 of which produce $NaClO_3$ and the remaining 3,200 produce $NaClO_4$. The $NaClO_4$ is then reacted with NH_4Cl (produced from reacting NH_3 with HCl) resulting in a double displacement reaction generating NH_4ClO_4 and NaCl. The process is a fairly simple one, a reasonably bright high school chemistry student could make Ammonium Perchlorate. The trick is to make large quantities of homogeneous material suitable for the manufacture of solid rocket propellant. Our largest single customer is the space shuttle program. We sell Thiokol 1.6 million pounds of Ammonium Perchlorate for each solid rocket booster motor set that is manufactured. We also provide material for various other space boosters and DoD missile programs.

Why Employee Involvement

Prior to addressing the WECCO experience with its Employee Involvement (E/I) program it is important to address the reason why WECCO or any other company would be motivated to get involved in this type of program. First we view our work force as our most important resource. They are the only resource we have that is capable of self generated improvement. Additionally they have the capacity to significantly improve the entire system of resource conversion.

The employee, when properly motivated and appropriately rewarded, has much to offer in the way of system improvement. There is not another individual in the organization that knows as much about how a task is performed than the individual who is performing it. Supervisors, managers or engineers may have greater knowledge of the way a job was designed to be performed or of the expectations of the job performance, but the individual employee knows best how it is actually being performed. He knows what works well and he also knows where the frustrations of job performance lie, and he knows those areas where resources are wasted or inappropriately applied. To a significant extent employees should be self motivated to make suggestions for improvement, particularly were a change will directly benefit them in their work performance. In that case they have an immediate reward for their effort. Their work is either easier or more rewarding.

In addition to the direct benefits to be derived from the successful implementation of the Employee Involvement Program, it is also useful as a device for introducing other Total Quality Management (TQM) related initiatives such as job ownership, team formation and structured problem solving.

Job ownership is a valuable motivator and significant internal reward mechanism for the employee. An employee who has defined or at least assisted in defining his work scope and task structure will be more apt to identify with that scope and structure and work toward successful performance. There is less likelihood of allowing a process to fail and then saying "I could have told them it wouldn't work that way." When the employee has an impact on the decision making processes in a company, it becomes his company. He identifies strongly with its successes and its setbacks, and he will maximize his effort to contribute to its success.

Teamwork is essential to the success of any organization. No organization or activity requiring the efforts of more than one individual can optimize its productive output without working as a team. Sub-optimization, the optimization of individual elements of an organization at the expense of the organization as a whole is the logical outcome of individuals, or organizational components, "doing the best job they can do." As an example the most efficient design for the installation of a new equipment, which would minimize the cost of installation and provide for the greatest conservation of installation materials, may create an inefficient production process and make maintenance of the equipment extraordinarily difficult. To optimize one activity at the expense of another is folly. Breaking down barriers between individuals and work groups through the creation of teaming arrangements will assist in overcoming the problem of sub-optimization. An individual or work group is more likely to accept the fact that some part of their activity is being performed in a less than optimal way if they understand that the inefficiency is required to optimize the performance of the entire organization. In order for teaming to be effective there must be an effort made by all parties to enhance communications both laterally and vertically in the organization.

In conjunction with the introduction of teaming as an optimization strategy it is important to introduce the use of structured problem solving tools. The establishment of teams within the E/I process provides both the structure and the need for these skills. Attempting to provide training for training's sake in these skills has proven to be ineffective. However, teaching the skill at the time when the need for the skill is readily apparent is a much more successful strategy.

Quite aside form the fact that a well managed E/I program will make the employees happier and more productive, a worthy end in itself, it should also make the company more money, and financial success for the company means employment security for the work force, and dividends for the shareholders. Increased earnings come from two sources, increased production, and reduced waste. The increased production is a result of direct changes in the work process and indirect changes in the attitude of employees. As attitudes about work improve, there is greater pride in workmanship and the beginnings of a "quality culture " set in. An added bonus in the process is that these changes also have the tendency to reduce

scrap and rework as process improvements take hold and employees (and managers) see the benefits of doing it right the first time.

Initial Implementation

Having discussed why we would wanted to initiate an E/I program, I will now describe our initial implementation of the program. Our program was established with the aid of a consultant. We created an E/I organization, overlaying the company's existing structure, composed of a steering committee (the president and his direct reports), an E/I coordinator, 17 employee teams (with E/I representatives elected by the team members), and supervisors and managers as constituted in the companies organizational structure.

Training was presented to the E/I representatives, supervisors and managers, by the consultant, with the intent that they in turn would train the rest of the work force.

The initial E/I process was structured much like a classic suggestion program. The employee was not involved in the process at all beyond the initial discussion of the "suggestion" with his E/I representative. Evaluation and acceptance or rejection of "suggestions" was a supervisor/management task. There was to be notification to the employee when the "suggestion" was accepted or rejected. The program had no recognition or reward system. There was some discussion of a gain sharing program to be implemented at a later date but that part of the program never materialized.

The results of the initial implementation of the program were an initial surge of "suggestions." The work force had a lot to say. The "suggestions," however, backlogged on the supervisors and managers desks. In some cases there was insufficient information on the "suggestion" form to allow adequate evaluation of the idea. In other cases there were just other things with higher priorities that displaced the evaluation process. The end result of the lack of involvement by the employees, lack of any recognition/reward system, and inaction on the part of the supervisors and managers was that the work force became disenchanted with the program and the generation of new "suggestions" slowed to a trickle. Those "suggestions" that were submitted were nearly all related in some way to making the job of the suggester more satisfying.

While E/I Teams were created in the initial implementation process, their formation was by fiat. Upper management proclaimed work groups to be teams. The "team" members were given no special training in teamwork or structured problem solving, and as a result, aside from electing an E/I Representative, the E/I team did nothing any differently after team formation than they did before the teams were formed. As an example, there are eight people in the security force, these eight people were formed into a team even though they work two people to a shift and would never, under ordinary circumstances, be together to do any teamwork.

Revision 1

In the spirit of continuous process improvement, the E/I program was reviewed and revised. The organizational structure of program was unaffected except for the addition of a TQM Coordinator between the Steering Team and the E/I Coordinator. Training in the revised program was again provided to the E/I Representatives, supervisors and managers. However, this time the training was presented by the TQM Coordinator and all the trainees were presented with a set of training aids designed to facilitate the training of their fellow employees.

The process changes to the program were threefold. First to increase the **employee** involvement in Employee Involvement. Second was to encourage, in fact require, the formation of ad hoc teams to evaluate the E/I ideas. Third was to provide some form of recognition/reward for participation in the program.

The first goal of the change was to increase the level of involvement of the employee in the evaluation process. We wanted the employee to assume ownership of his "idea" and to champion it through the process. By establishing evaluation teams (to be discussed at greater length shortly) and placing the employee with the "idea" on the evaluation team we not only increase the level of communication about the "idea," but provide recognition and feedback to the employee. As part of the evaluation team he is able to describe in far greater detail the need for implementation of his idea and to describe the actual characteristics of his proposed solution to the problem. The employee is also in a better position to understand the reasons why his "idea" may not be in the best interest of the organization as a whole and not view the rejection of his idea as a personal failure, but rather as a learning experience.

The formulation of evaluation and decision making teams fosters the goal of teamwork. The initial team is composed of the employee, the E/I Representative and the employees immediate supervisor. The initial task of the core team is to identify and seek input from any stakeholders from other areas of the organization that may be affected by the implementation of the "idea." These other stakeholders may be people like maintenance, other shifts, purchasing, etc. The expanded team them analyzes the "idea" and recommends approval or rejection. If the cost of implementation requires approval at a higher level, the recommendation is carried to the next level in the management chain by the suggester, again providing him with recognition by his seniors in the organization and the opportunity to sell his idea to the decision maker.

In the area of recognition and reward, we did not want to get involved in a cash for ideas program. Placing a value on an employees idea can and often does create animosity and works to counter the empowerment, morale heightening goals of the program. What we did was to provide the employee with a certificate of appreciation and a "WECCO light bulb" decal to be displayed on his hard hat for each approved idea. These are presented by the president of the company at the weekly management meeting. Additionally, from time to time, drawings for "prizes" are held to award participation in the program. In these

drawings, the employee gets a chance to win for each "idea" submitted whether the "idea" was approved, rejected, or is still under consideration. Finally, for ten approved "ideas" the employee is provided with a dinner for two at a fine local restaurant.

As a result of the restructuring of the program, there was a push to work the backlog of "ideas." The number of new "ideas" showed an initial increase and then settled into a steady state, and we observed a broadening of the participation base.

Progress Review

We were pleased that we had a positive outcome from the restructuring but when other concerns in the facility provided the motivation and the opportunity, we performed a progress review. The review should have been done in any case as part of the PDCA cycle. With respect to the E/I program our purpose was twofold. First to discern the perception of the program from the employee point of view and second to determine how well the employees understood the principles of the program. The progress review consisted of interviews of the entire work force in small groups of from 1 to 5 individuals.

As a result, it was found that everyone was aware of the program but that the training to have been provided by the E/I Representatives and first line supervisors had not, in all cases, taken place. Additionally, only a few of the "ideas" were being processed in accordance with the new procedure, ie. evaluation by teams composed of all stakeholders. Most employees were still not involved in the decision process, and there was a general feeling of isolation rather than inclusion in the work force.

These findings took us back to the PDCA cycle and we have initiated plans to retrain the work force, and to accommodate input received from the interviews into a revised procedural document. Among the issues to be accommodated are difficulties encountered by employees working on night shift being un able to adequately team with stakeholders on day shifts, inter-shift conflicts, and supervisory support (or the lack thereof).

Conclusion

In a small company where managers are expected to wear many hats, it is not an easy matter to initiate and maintain a new program like the E/I program. As with any other system entropy will take place. Unless energy is continually input into the system it will degrade into an inert mass. People oriented systems require high levels of attention in order for them to continue to perform at optimal levels. Like the plate spinner on the old Ed Sullivan Show, the manager in a small business must keep an eye on all his responsibilities and run back and spin the wobbly ones back up or face the consequences in failed programs.

In conclusion, like any other process, an E/I program is subject to continuous process improvement, and talking to the employees is one of the best sources of information to institute process improvement.

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C2 Education Success Stories

This panel will highlight practical success stories relating to the educational sector that demonstrate how Continuous Process Improvement (CPI) has been applied. Presenters will discuss curriculum development and improvement and industry/government/education teaming to enhance the learning process and the quality of education.

Dr. William C. Parr, Director and Professor, College of Business Administration, University of Tennessee, **"Holistic MBA's, Experiences in Curriculum Reform."**

Sandra J. Wells, President, Wells & Associates, AND **Mack E. Hughes**, Principle, Brown Street Academy, **"Teaming for Success in Education."**

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Holistic MBAs -- Experiences at Curriculum Reform

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Abstract:

The University of Tennessee has just completed a complete overhaul of their MBA program. Extensive customer (student and hiring company) input stimulated this overhaul. These organizations participated in design and development of an integrated cross-functional curriculum designed to meet the needs of modern business, industry, and government.

Why would a respected Masters of Business Administration program at a major university change? What would it take to provoke a major, wide-sweeping reform of curriculum and teaching methods? What could possibly motivate tenured faculty to lead and participate in such an effort?

Just such a change effort has occurred at the College of Business Administration at the University of Tennessee. This new, zero-based curriculum design is complete, and the second class to experience the new curriculum began in August 1992. The purpose of this paper is to discuss: i) the history of the UT MBA program and the rumblings in the external world which caused the idea of reform to surface, ii) the immediate causes of this change effort (student inputs, industry reaction, and the faculty response), iii) the situation at the University of Tennessee which provided the fertile ground supporting the change, iv) the response -- a description of the process for designing the new curriculum, v) a description of the new design, iv) the results of the change -- faculty learning and feedback from students and industry, and vii) lessons learned and future predictions.

The Gathering Storm

A recent open letter by six prominent CEOs of Fortune 100 corporations issued the following warning: "Academic institutions that are slow to embrace TQM, at best, miss the opportunity to lead change and, at worst, run the risk of becoming less relevant to the business world." Bob Kaplan of Harvard University has stated "Business schools, like other declining U. S. industries that adjusted slowly to environmental, technological, and competitive changes, will find it difficult to survive at the same scale of industry share and margins."

What has provoked such condemnation? Nothing but the clear perception that business education has become increasingly irrelevant to the needs of the modern business community. One critic has posed the question "How can our business schools be so good if our businesses are doing so poorly?"

In the words of the report "Leadership for a Changing World: The Future Role of Graduate Management Education," of the Graduate Management Admission Council, we will require "a new synthesis between academic rigor and managerial rigor."

The Immediate Causes of the Change

At the University of Tennessee, all was not quiet in the spring of 1990. The faculty and administration read the publicly available reports assailing MBA programs. Graduating classes and hiring companies commented at increasing volume about the mismatch of the curriculum and skills of the MBA graduates to the current needs of industry. Declining enrollment trends were well documented, and will not be repeated here. Scarcely a week passed without another article in a prominent magazine which repeated criticisms of MBA curricula.

In the spring of 1990, a MBA faculty retreat was organized. At this retreat, representatives of three organizations -- Procter and Gamble, Xerox, and Texas Instruments -- were invited to present their hopes for MBA education to the faculty. The results were predictable. The three speakers presented their hopes for reform with great force and eloquence. They also expressed amazement that a faculty had finally decided to at least listen to industry. (One of the industrial representatives commented "Don't get us wrong. We think that your products are broken. But so are those of all the Universities. And you're the only University that's listening to us.") The three speakers also expressed dismay that when they hired graduates of the University of Tennessee MBA program, they would typically need to send them back to the University of Tennessee Management Development Center (MDC) for management education within the first two or three years, to obtain content they were not given in their MBA curriculum, but which was routinely offered in MDC programs.

Following the three speakers from industry, two students currently in the MBA program had the opportunity to speak. In the words of one faculty member, "surely these two will be nicer to us." They quickly expressed agreement with the industry representatives, and presented their hopes for reform.

Shortly after this retreat, focus groups of MBA students were formed, to better understand their experience in the MBA program, from their point of view. These inputs strongly reinforced the words from the industrial speakers and student representatives at the faculty retreat, providing anecdotes and a near - unanimous student assessment of how desirable reform was.

The short-term result of these inputs was a call for reform. The Dean of the College of Business Administration, C. Warren Neel, convened a faculty task force to create a vision for a new MBA program, and to lead the college in the creation of that program.

This group's products were several: i) a white paper which summarized their vision for a new MBA program, written after several months of work and consultation with industry, ii) a college united behind that new vision, and iii) a critical core of committed faculty who would create and teach that new MBA program.

The vision for the new MBA student contained the following: a top priority on customer value, an integrative, cross functional emphasis, a lifelong commitment to learning, analytical skills, an understanding of systems, a sense of the true responsibilities of managers, a sense of organizational reality, and enhanced interpersonal skills and leadership skills.

The Fertile Ground for Change

Why was the ground fertile for change at the University of Tennessee? The primary reason was the close relationship of the faculty to industry. Unlike faculty in many colleges of business, the faculty at the University of Tennessee had regular close interaction with industry through the Management Development Center (MDC) , an organization providing executive education to industry. The MDC provides the faculty with experience working with managers from many organizations (80% of the Fortune 30) at improvement within those organizations, and at implementing new managerial roles in those existing organizations. It also provides the faculty with experience at alternative teaching methods -- experiential methods figuring prominently in MDC programs.

The Process of Change

After the call for change documented in the white paper created by the task force was accepted by the College of Business Administration, the core faculty was formed. This core was a group of 12 faculty (now expanded to 15) representing all disciplines of the college. This group of faculty took on the responsibility for joint design of the new program, creation of that program, and delivery of that program to the MBA class slated

to enter in August of 1991. Given the nature of the changes contemplated, this was a daunting challenge -- the core faculty group was formed in the early fall of 1990, by an all - volunteer group of faculty. In order to better survive in the face of existing reward and recognition systems at the College of Business Administration, only tenured faculty were involved.

Those in the core faculty had certain common characteristics: a strong interest and substantial experience in management education, an interest in applied and field research, a desire to advance the MDC principles of management of systems for customer value, an interest in non-traditional pedagogy, and a willingness to work in a team environment in the new curriculum, for both creation and delivery of that curriculum.

Several guiding principles for the curriculum emerged after careful consideration and consultation with industry.

First, the three hour course was abandoned. The three hour course model was found to reinforce the functional silos which are such a problem in industry, and were a barrier to faculty communication. The new curriculum is not a set of eighteen courses, each managed by a different faculty member, with loose collaboration. Instead, the entire first-year curriculum consists of two courses (15 hours credit each), which are jointly managed by the core faculty.

Second, topics and methods are introduced through a just - in - time approach. No tool is introduced until its relevance to the management task has been established. The device for accomplishing this is an integrated, year - long case, "Volunteer Vegetables," discussed below.

Thirdly, since leadership and interpersonal skills are vital, they are emphasized throughout the curriculum. Work is done in teams of five or six students. Students are put in stressful situations in which success requires cooperation within the team, and between teams. Teaching highlights experiential learning.

The guiding principle for the content of the curriculum is simple -- we teach in the required (core) curriculum only that which every manager needs to know as a practicing

manager. We do not teach, in the core curriculum, topics which have been historically covered "because they're needed for the next course in finance, economics, . . ." Implementation of this guiding principle was painful. It required that individual faculty surrender their old "ownership" for their three hour course, and argue for the relevance of their material with their colleagues. Each faculty member entered the "dock" and presented and discussed the rationale and fit for the material they proposed for inclusion in the program. A professor of management had to convince professors of finance, marketing, . . of the match of their proposed material to the guiding principle of being required by the practicing manager. This discipline forced the faculty to develop a solid, reality - based approach to selection of material. They were forced to talk to industry to learn more about the challenges faced there, and to respond to the needs of which they learned.

The Product of Change

An overview of the highlights of the first year of the curriculum may be helpful. Strong emphasis is given to personal and interpersonal skills (including team-building), systems thinking, and the driving principle of customer value. Financial analysis and macroeconomics are greatly de-emphasized, compared to the old curriculum. (Paradoxically, for example, the students appear to be more able to use the tools of financial analysis, in spite of less time spent on them! Perhaps knowing the purpose of the tool helps to focus the mind more than knowing more of the complex underlying theory.)

Students develop a broader perspective of the "role of the firm" through time spent on the relationship between the business and the world around it. Sessions on ethics and business law define the relationship of the business to stakeholder groups.

Students spend the last two weeks of the first year in the Market Place simulation, a reality simulation which captures the qualitative and quantitative dimensions of marketing decision making in the context of an ongoing business. Students survey the market (microcomputers), identify and evaluate market opportunities, design and execute a marketing program, monitor their performance and that of their computation, and adjust strategy and tactics as needed. Relationships between the manufacturers and the distribution channel must be developed. The result of this extensive simulation

is that the students must integrate their learning on marketing, product development, manufacturing, finance, negotiation skills, and other topics in a holistic two-week capstone experience.

A substantial amount of MBA student time is spent on off-line learning activities. These include an assessment center. The purpose of this assessment is developmental, to give the student extensive feedback on their strengths, weaknesses, and interests. Subsequent work is customized for each student based on the diagnosed needs for development. Students attend a series of seminars on the business placement process, learning how to interview, business etiquette, and other topics of relevance. Mock interviews are helpful in the process.

Field trips to organizations such as Phillips Electronics, Saturn, White Lily Flour, and Toyota are highlights of the first year curriculum. A wide number of outside speakers are brought in to meet with the students. Recently, speakers included Tom Johnson (President, Cable News Network), W. Edwards Deming (consultant), Ruth Wooden (President, National Ad Council), Roger Smith (former CEO, General Motors),Donald E. Peterson (former CEO, Ford Motor Company), General Colin L. Powell (Chairman, Joint Chiefs of Staff), David Kearns (former CEO, Xerox), Frederick W. Smith (CEO, Federal Express), Elizabeth Dole (Secretary of Labor), T. Boone Pickens (CEO, Mesa Petroleum), and Gerald R. Ford (39th President of the United States).

Students spend the summer after their first year working as interns. This opportunity enables students to apply what they have learned in the first year.

The integrative case, "Volunteer Vegetables," deserves more discussion. This extended case continues throughout the entire first year of the curriculum, and figures in the second year also. It is the University of Tennessee response to the question: How do you teach the necessary functional expertise while also conveying an understanding of systems? We believe that students learn best when they are required to use what they are learning.

During the first week of class, the student inherits a significant portion of the stock in a hypothetical company, Volunteer Vegetables (VV), a canner of fresh vegetables and product made from dried beans. During the year, the company faces a number of

challenges, called milestones. The students must (in their teams) address these issues, and make recommendations.

The first challenge is that of understanding customer value. In Milestone I, the students must learn what their customers value, prepare a written report on their learnings based on in depth customer interviews, observation, and focus groups, and make a presentation to faculty and managers of local vegetable processors. This Milestone requires the student to understand the concept of customer value, and marketing systems. To carry out the project in a team context, the student must develop greater skills of oral and written communication, and in working in a team. Students also learn to function in an ambiguous environment. The assignment is intentionally somewhat ambiguous, forcing the students to select what is important and reject what is not.

The second major challenge, Milestone II, occurs when a local bank threatens to pull VV's line of credit. To respond to this, students need to determine and project financing needs for the next several years. This requires the creation of pro forma financial statements, which requires an understanding of physical flows of materials, seasonal behavior of the markets and the supplier base, and the fiscal consequences of these flows and behaviors. As one would expect, students find financial analysis much more interesting when they have a concrete reason for use of these tools. Students present their request for extension of VV's line of credit to faculty and bank loan officers, in a local bank.

The third major challenge, Milestone III, occurs when a major supermarket complains that shipments from VV are too often late or incomplete, and express problems with product quality. Threats are made to drop VV as a supplier if the situation does not improve. The teams must address this situation. In responding, students must apply all the skills learned thus far in the curriculum to managing the entire product pipeline, starting with their suppliers and finishing with their customers. Their summary report and recommendations are presented to faculty as well as managers from the vegetable processing industry.

The final challenge, Milestone IV, requires the students to conduct a feasibility study for a possible new product - microwavable packaging of vegetables. This milestone requires knowledge of demand estimation, market opportunity analysis, new product

design and development, and capital markets. Student teams present their findings to faculty as well as managers from the vegetable processing industry.

A brief overview of some "structural issues" may be helpful. Students meet in classes twice per day, for a total of two and a half hours per day. Material is scheduled based on need, with the Volunteer Vegetables case driving the scheduling of sessions on specific content. (The syllabus is presented to the student at the beginning of the semester as a schedule of what will happen in class each day of the semester, with the associated reading and work assignments.)

Students do their work in teams of five or six. Cooperation is built into the curriculum, with experiences constructed to make cooperation the only possible mechanism for coping with the challenges of the curriculum. Students turn in joint writing projects, reports, make joint presentations, prepare for cases together, and otherwise function with their teams as their basic study and work unit. Due to the stress induced, students receive extensive advising from faculty -- each faculty member working with a team of students.

How is all of this managed as an ongoing operation? The core faculty meet at least once every two weeks, often once per week. These meetings last from two to four hours, and focus on ongoing management of the curriculum, including improvement efforts as well as keeping all faculty informed of student progress.

The Results of the Changes - Feedback

What are the results? What has the feedback been?

Feedback was solicited throughout the year. Students held town meetings to discuss issues of common interest. As a result, they organized to develop an organized assault on the media, obtaining publicity for the new program. They developed an outreach program to develop more internship and employment opportunities for themselves and future classes.

For an overall assessment, some quotes from industrial observers may be helpful:

"It's about time we put the customer first, and the new MBA curriculum at the University of Tennessee, Knoxville takes a giant step in that direction," -- John M. Cranor III, President and CEO, Kentucky Fried Chicken.

"The University of Tennessee has done a reality check on its MBA Core Curriculum and come up with a winning formula for the University, the student and industry. The new curriculum, which focuses on the systemic relationship of functions within a business, will produce graduates better equipped to lead in a global world which requires deft, real time interaction of functional skills across buyer and seller - whether the product be a durable, consumable or service. Dean Neel and his associates are to be congratulated." -- L. D. Milligan, Jr., Senior Vice President, Procter & Gamble Company.

"I think that the approach the University of Tennessee has taken in changing its Graduate Business School curriculum is very positive. The University truly understands the holistic characteristics of total quality and has incorporated this as the basic fiber of their first - year MBA program. This approach that incorporates "just-in-time learning" is creative, unique and right on the mark." -- Norman E. Rickard, President, Xerox Business Services.

Student feedback has been familiar. Two students, Colette S. Cocco and Dariel Mayer, have written "We see clear successes. Strongly class cohesiveness was important. In addition to working together in small teams, work units cooperated with each other. Also, we worked well as a class by organizing petitions to the faculty when we saw the need for an immediate change in some aspect of the program. The partnership between the faculty and the class was successful in that it was flexible enough to rearrange the pieces of the program and still tie it all together in the end."

Lessons Learned and Future Predictions

What has been learned from all of this?

Several principles emerge. One is that the program arose due to leadership from a small, almost entrepreneurial group of faculty. Although membership was viewed as

"risky" by most faculty (endangering research programs), a sufficient number of creative faculty took the steps required to create and deliver the new curriculum. This required a major investment in their time, and of college resources. The faculty who spent extensive time on creating this program are also major players in the executive education programs of the college, and in their own departmental degree programs. Hence, the opportunity costs of pursuit of this program were substantial.

Faculty were required to cooperate to create and deliver this program. This is a substantial progress item. Historically, cooperation between faculty has been the exception, not the rule. For the MBA program, cooperation was required both within and between departments. Faculty had to give up the view of their courses as their own private domains. Competition between students had to give way to cooperation.

What is likely to happen in the future?

It is unlikely that we will ever move back to "things as they were before." The faculty and students see the benefits of the new way far too clearly. The changes are likely to accelerate.

In the second year of the curriculum, students specialize, concentrating in (typically) two fields of their choice. We expect that the students will act as change agents, driving new ways of thinking about content and pedagogy into the minds of the faculty teaching in the second year of the curriculum.

We continue to revise our methods for offering the students feedback. One student wrote the author "I never obtained so much helpful feedback in my entire life." Improvement of feedback to students will be a major area of improvement.

Is the redesign effort over? It will never end. Continual improvement of systems is a way of life within the University of Tennessee, and not only something taught in the classroom. At this time, two months into the second time through the first year curriculum, we are still aggressively improving the curriculum.

Acknowledgments

The curriculum reform described in this paper, as well as much of the formulation of this paper, are in reality the work of the team of core faculty described in this paper. The current author is of course responsible for this exposition, but wishes to acknowledge his colleagues on the core faculty, his colleagues in industry who have so generously contributed their ideas and feedback, and to the students, past and present, of the MBA program at the University of Tennessee. In addition, he would like to thank the Management Development Center and the Center for Advancement for Organizational Effectiveness for providing the living laboratory in which faculty work with industry, continually learning and bringing that learning back into the curriculum of the College of Business Administration.

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TEAMING FOR SUCCESS IN EDUCATION

Mack Hughes, Principal, Brown Street Academy

Sandra J. Wells, President, Wells & Associates

The headlines of American newspapers and periodicals often proclaim that American school children are not receiving a quality education, that dropouts and illiteracy are growing daily, and that dissatisfaction with curriculum and public education are leading to a demand for tax credits and more choice in primary and secondary education. Along with low scores on standardized tests and poor preparation for job attainment, there is genuine concern that any world-wide competitive edge we may have possessed in science and technology will diminish as our schools fail to meet the challenges of a changing world. Increasingly, demands are being placed on our school systems to produce high quality products (educated students who can be productive members of society) with fewer resources (shrinking tax bases and fewer teachers).

A major way in which American educators are responding to the challenges is to break the old paradigm of centrally managing the education system and processes. Throughout the country, innovative educators are incorporating the power of collaboration and partnership as a way to improve their classrooms and school districts through Site-Based Decision Making (SBDM). Also known as Site-Based Management, this process decentralizes decision making to improve educational outcomes at school campuses. This occurs through the collaborative efforts of principals, teachers, campus staff, district staff, parents, and community representatives. They work together to determine goals and strategies and to ensure that strategies are implemented and tailored with the end goal of

improving student performance. Site-Based Decision Making, then, is a process whereby participation is needed by all relevant stakeholders to produce a quality-driven output: improved student performance. It is not unlike the basic participative processes that support self-directed work teams and empowered work forces in the business and commercial arena.

How is SBDM a different way of managing school districts? Traditionally managed school districts have hierarchically arranged organizational structures that provide information and decisions in a top-down format. SBDM provides flexible, functionally arranged organizational structures that can enable shared team decision-making. Traditional district goals are dictated by school board priorities and district-wide needs assessments, while SBDM goals are determined at the campus level -- through inputs of staff, faculty, and community. This may entail an analysis of student performance factors and student demographics. SBDM implementation activities are self-directed and initiated by campus staff, not mandated by district level administration. Allocation of resources in SBDM is not solely determined by a central dispensing organization or based on the priorities of administrators, but is accomplished

and controlled at the campus level, based on local campus needs and priorities.

SBDM also impacts how decisions are made about classroom instruction. The participative process allows staff selection at the campus level using guidelines reflecting team instructional needs and which are developed by faculty. This selection process is different from one that has the central district office hiring teaching staff who match "prescribed" qualifications and characteristics desired by the district policy makers. In SBDM, teachers have a greater ability to revise curriculum and revise instructional methods as necessary to meet needs of students quickly. In traditional systems, curriculum revisions may be standardized across grade levels at all campuses and cumbersome procedures may inhibit revisions. Evaluation of student performance in traditionally

managed districts is conducted at a set time of year by campus, subject, and grade level to provide aggregate group profiles; in SBDM campuses, although aggregate profiles may be collected for generalization and research, evaluation of individual student performance is the key and is on-going to provide real-time information to the teacher upon which instructional decisions may be made.

School districts which are implementing SBDM expect the following outcomes: effective campus and district planning; improved community involvement in the school improvement process; clearly established parameters for student performance; raised staff productivity and satisfaction; improved communication and information flow; consensus-based, effective decisions supported by all stakeholders; long-range commitment to changes; increased flexibility at campus level to allocate and to assign fiscal and human resources; and tailored coordination of programs that meet the needs of all students.

With the adoption and implementation of Site-Based Decision Making, the roles of administrators, principals, teachers, community, and parents change from the traditional model of school management. The role of the Central Office, the Superintendent, and the School Board changes from enforcer and policy maker-mandator to one of providing service and support. One creative school district changed the name of the Central Office to Service Office, signifying that the campuses were the customers for the administrators and, as such, the administrators were committed to providing technical services and support to the respective schools. The role of the school principal changes from sole decision maker at his/her school to a facilitator of school faculty to participate in decision making in relation to setting goals, determining budget, development of staff, and curriculum. The school principal becomes a coalition-builder with the community and parents, raising the awareness of campus efforts for improvement and encouraging involvement. The role of the faculty member expands to become not only immediate service provider as front-line teacher/educator but also being an initiator, implementor,

evaluator for change activities. Skills that enhance faculty member abilities to perform as team members who participate in consensus-based decision making are vital.

The role of the parent is one of involvement and contribution to policy decisions. This means providing support to campus activities and change efforts often in other-than-monetary ways. Parents are key to establishing direction and support for campus efforts. A recently selected U.S. Presidential Excellence school in Texas, Hill Country Middle School in Austin, was commended for the ways in which parental involvement has made a difference in daily operations. As part of parental involvement strategy of that school's principal and faculty team, parents are encouraged to attend monthly principal meetings, are involved with goal setting for the school, assist teachers with courses and extra-curricular activities (such as providing support for students who participate in sports). Parental involvement encourages a sense of extended family in the school .

The role of community and business is one of support and feedback to the school system. Innovative ways of assisting the schools to accomplish their goals, again through services or non-monetary support, result from the community involvement. The Tom Thumb/Simon David grocery chain supports neighborhood schools by donating computer equipment to the schools that collect store receipts. Other community organizations provide internships for school seniors or help develop course curriculum for specific post-school employment.

The advantages of the SBDM process are flexibility, adaptability, responsiveness, respect for uniqueness and individual differences, pride, involvement and commitment of teachers, parents, school administrators and staff, students, and community. When stakeholders are involved in planning and decision making, there will be an increased commitment to and support of school decisions. This will, in turn, lead to improvement in the development of the skills necessary to the academic and future success of our students.

As in any organizational change effort, certain elements are critical for successful implementation of Site-Based Decision Making. The values and beliefs that underlie participation must be practiced. Respect for the individual and his/her contributions, use of a democratic decision making style (consensus) which includes inputs from those affected by change, understanding that group synergy yields a higher quality decision than a decision made by one person, and use of collaboration to build relationships to work toward superordinate goals and "win-win" outcomes rather than creating adversarial positions are all essential.

Also essential is incorporation of a key tenet of total quality or continuous improvement: developing a customer service orientation. Determination of who is the customer and what constitutes satisfaction of customer needs means interaction and dialogue with the customer. The attitude of "I know what's best for them" must be replaced with "what needs does this customer have and how can I best satisfy them with the skills and knowledge that I have?" In the case of schools undergoing change that is focused on improving their preparation of students for the real world, this means a change of attitude from "we're the educators, we know what students need" to "where will these students be functioning and what will they need to be successful there?"

Educators must be focused outside their institutions to meet the needs of students, communities, industries, and society. The assumption that students who comply with prescribed curriculum which requires ""x" courses or "y" subjects be completed are no longer valid. Results-driven program planning requires educators to be more than subject matter experts: they must also be responsive and capable of adapting to changes. Many of those in education would no doubt indicate that they have indeed attempted to be responsive and flexible in meeting student and community needs in the past but have been hindered by the bureaucracy of the central office. Superintendents and School Boards may contend that, but for teachers, they have tried to institute policies that support this

customer driven approach. Regardless of which side of the issue one supports, the point of Site-Based Management is that there are no sides and that barriers that inhibit involvement be eliminated. Teams must be created within campuses, within districts, with parents, with community organizations that may ultimately employ graduates, and with students involved. Now is the time for partnerships, collaboration, and commitment. It is imperative that mutual goals be established and that all affected by the education system work side-by-side to improve the process.

An example of Site-Based Decision Making where extensive community and parental involvement has resulted in a model school is the Brown Street Academy of the Milwaukee Public School System in Milwaukee, Wisconsin. For the past three years, this pre-K to fifth grade school has been involved in implementation of Site-Based Management characterized by strong business partners working in coordination with the school staff and administrators. These business partners bring special skills, talents, and support to school operations. These partners have been "institutionalized" as part of the SBDM process; there is a liaison officer from the Wisconsin Gas Company who has a formal position on the school's Site Based Management Council. This Council developed the overall strategy for implementation of SBDM at the school and the Wisconsin Gas Liaison Officer, Ms. Diane Kippert, plays an on-going role in goal setting and overall strategy development. The Council has helped the development of "themes" for the school: this year's themes are Cooperation, Fantasy, and Patterns.

Currently, the school's business partners include not only the Wisconsin Gas Company, but also the North Milwaukee Bank, Northwest Mutual Life Insurance, Wisconsin Bell Company, the U.S. Attorney's Office, Miller Brewery, North Suburban YMCA, the University of Wisconsin-Madison, the Fire and Police Commission, and the Milwaukee Sewage District. Since the development of the business program, members

have included representatives from IBM, the Federal Bureau of Investigation, the City of Milwaukee, and the U.S. Treasury Department.

These business representatives have been actively involved in the school's programs participating in the overall goal setting as well as in such diverse ways as presenting learning modules for fifth graders, helping conduct fund-raising drives, and conducting special programs. Activities in the past year have included "The Wiz," co-produced by the children and their business mentors as a full-scale musical production and a "Folk Fair" that explored world cultures and diversity. In the "Folk Fair," business partners worked side-by-side with the children in setting up and manning food and display booths. For the Spring Musical, the Gas Company published all advertisement and ticket sales information. This fall, the North Suburban YMCA is planning a project that will take a number of students to the facility and the "Y" will sponsor a three day conference that explores the Fantasy theme for the children.

It is a common occurrence at the Brown Street Academy to see a business representative present a career day program to classes or to have them assist teachers by presenting a work-world module of instruction while the teacher is involved in other school SBDM activities. Teachers are provided opportunities to participate in leadership programs of their business partner organizations as part of their professional development. Additionally, collaboration among school staff, business partners, and parents has made a special program, "Talent Development," a reality at the school. This program is targeted for the children in the extended after school care program conducted at the Academy. Recognizing that the children in this program are from the inner city and have a demonstrated need for attention and esteem-building, Talent Development links children with an adult contact to help focus on the uniqueness and special talents that all children possess.

The Brown Street Academy has integrated the community and business into the day-to-day school activities. creating a school environment where the "outside" world has become a vital part contributing to the school functioning. The school does not operate in a vacuum. It receives tangible support and assistance from its business partners, as well as role models and an infusion of care and interest from the business world. Business partners experience a sense of involvement and the feeling that they are contributing to the success and development of the school children. There is a reciprocity in this relationship.

The continued support and involvement are testimony to the qualitative measure of success of the program. Quantitative measures (i.e. test score improvements, increased attendance, fewer days of absenteeism) are being tracked for the school, with data supported improvements over the three year old program. In some subject areas, test score improvements of over twenty points are being recorded.

The Brown Street Academy is part of a longitudinal study being conducted under the auspices of the University of Wisconsin-Madison. This study is monitoring children's after school activities over time to assess the quality of their experiences and the effect they have on development. This is a timely concern since schools nationwide are being pressured to provide after school care as an extension of the educating role and help provide support for "latchkey" children. The after school care program at Brown Street Academy provides supervised care for children that does more than a simple "babysitting" service while creating additional opportunities for growth and development. The University Project is in its second year with preliminary findings demonstrating that this school program has positive effects on its student participants.

The implementation of Site-Based Decision Making at the Brown Street Academy has been successful due in large measure to the establishment of partnerships between the community and business organizations and the school, its students, and parents. The

school and its "extended family" demonstrate how well collaboration can serve the students and encourage them in their educational and personal growth and development.

The school has become dependent on the support of its business partners and they, in turn, appreciate the role they play in civic responsibility. They are demonstrating in a very real way that they are not only concerned with the education of the Brown Street children; they are doing something concrete about it. The school, the administrators, the parents, and the "turned on to school" children are working toward the academic success of their city's children.

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C3 Government Success Stories

This panel will address the unique opportunities facing government agencies and present successful case studies that demonstrate meeting the challenges in an environment of declining budgets.

Dr. H. David Shuster, President and Founder, Suda (DASU, Inc.); **Gene Fisher**, Director of Engineering, AND **Pat Malone**, Associate Executive Director for Quality, Port Hueneme Division, Naval Surface Warfare Center; **"Evolution of Cultural Change in the U.S. Navy: Applications of Teaming and Process Management Principles and Practices."**

Thomas C. Staab, Director, Total Quality Management Office, Defense Finance and Accounting Service, **"Implementing TQM Takes Time and Patience."**

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Evolution of Cultural Change in the U.S. Navy: Applications of Teaming and Process Management Principles and Practices

By

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INTRODUCTION

This is a story of partnership between a public and private organization, together seeking an evolution in management. Old myths have been challenged and new legends born. The journey, although twisting and bumpy, continues into the future. There is no final destination. But, there are horizons...frontiers to be expanded and pushed outward.

The ultimate end is to celebrate both human individuality and the bonding of distinct personalities into an enhanced community of great purpose and worth. That purpose is to serve a larger and meaningful enterprise with distinction, satisfaction and joy.

WELCOME TO "NEMESIS"

The Port Hueneme Division, Naval Surface Warfare Center (PHD NSWC), commonly called "Nemesis" (surviving from a previous Station title acronym), serves the Fleet of the United States Navy (USN); which, itself, serves our larger and most meaningful national interest. The published Nemesis mission is to:

> Provide test and evaluation, in-service engineering, and integrated logistic support for surface and mine warfare combat systems, system interface, weapons systems and sub-systems, unique equipments, and related expendable ordnance of the Navy surface fleet. Execute other responsibilities as assigned by the Commander, Naval Surface Warfare Center.

he vision of the people of Nemesis says that:

> We will be recognized by our customers for providing the best possible products and services to the fleet through the innovations and quality of our people.

Nemesis was established in July, 1963, with six military, 38 civil service, and 14 contractor personnel to support 45 ships and 124 systems. Today, it serves hundreds of ships and systems, employs over 3000 military and civilian personnel, and hundreds of contractor personnel; spread over the original Port Hueneme Station and three other sites.

MANAGEMENT TRANSFORMATION HISTORY

Several years ago, the Department of the Navy (DON), decided to adopt the principles of Dr. W. Edwards Deming as their common model for management improvement. Navy personnel certainly do not ignore the ideas of other experts. But, they have decided that Dr.Deming provides a worthy and useful common language and focus for communicating management transformation ideas across their widely dispersed community. The Chief of Naval Operations, Admiral Kelso, also titled the DON enterprise, Total Quality Leadership (TQL), a term that is now quite familiar throughout the Navy.

Nemesis personnel began their transforming journey almost a decade ago, long before these decisions were made. The evolutionary character of their passage is illustrated best by tracking the changing "mindsets" that define their efforts over the course of time. The following calendar approximates the ebb and flow of viewpoints that drifted across the Station as people struggled to confront ideas that often seemed familiar, yet odd; logical, but almost contradictory:

YEAR	MINDSET
1984	* Efficiency is the goal. * Productivity is the answer.
1985	* Quality is a program. * This is just good problem solving like we have always done.
1987	* Measurement is the answer.
1988 (DoD TQM)	* Doing quality is outside our regular job. * Quality is our job.
1989	* Quality is a philosophy, but you pick and choose from the "gurus."
1990	* Managers must assume a transforming leadership role. * Everyone must participate * We must transform our culture.

The maturing trend of these mindsets is most evident in the steadily increasing willingness and ability of Station personnel to admit the need for altering entrenched attitudes and behaviors, and to accept personal accountability for radical change. Peoples' "psychological readiness" for internalizing a pivotal management metamorphosis is steadily increasing; some people moving

more rapidly than others. It is both unrealistic and unreasonable to expect everyone to stir themselves at the same pace and direction as their peers. That is why "constancy of purpose" is so crucial to long term evolution. Withdrawing from addicted attitudes and behaviors is very painful. It requires people to both "want" to change, and to "know how" to change.

SOME DEMING FUNDAMENTALS

Dr. Deming challenges people to recognize that management, no less than physics, biology, or economics, is a discipline. Therefore, to understand management "profoundly," is to accept the fact that good management practices are based on theory. He asserts that it is not enough for people to work harder, smarter, or even together. They must act according to proper management theory. The "aim" is to "optimize the system" within which every organization operates. Deming defines optimized systems as "WIN-WIN" oriented; i.e., no one wins unless everyone wins.

These two concepts, profound knowledge, and optimizing the system, are axiomatic for Deming. All else (the 14 points, process variation, the deadly diseases, beads, funnels and other jewels), flow from, and serve, these assumptions. They also form the foundation of this history.

NEMESIS AND SUDA TOGETHER

Nemesis has acquired the assistance of many management transformation experts. One of them, Dr. H. David Shuster, has participated from the start; first as an engineering and logistics contractor, and then as an authority in management transformation. What follows is a somewhat detailed account of how Nemesis and SUDA, Dr. Shuster's company, have associated to internalize two specific management transformation practices into the fabric of Nemesis life; "teaming," and "process management."

Management transformation contractors offer three basic long term services to clients. The first is education; ensuring that they understand sound management theory. The second is internalization; ensuring that they practice that theory in everything that they do. Finally, contractors must ensure that clients are ready, willing, and able to carry on when they leave. SUDA and Nemesis have strived to assure the success of all three enterprises.

A partial list of specific accomplishments is addressed later in this paper, however, a "sense" of progress is offered here in the form of typical comments heard around the Station:

* Individuals involved in formal teaming are accepting the approach as "natural" in their daily associations.
* There is an increasing inclination to approach problems in terms of "processes," and to resolve them in teams.
* There is an increasing tendency to "get the facts."
* I see evidence of increased trust in the teaming process; skepticism is down.
* Facilitators are having an easier time "selling" their processes.
* Facilitators are more in demand; being "pulled" rather than "pushed."

* Individuals are less reluctant to join formal teams.
* Teaming is on the increase in daily work environments.
* Teaming behaviors are "spilling over" into daily work.
* People seem to be criticizing less, "piggybacking" more.
* New attitudes and processes are slowly emerging in the management ranks.
* New practices have survived five rotations in command.
* Trust is on the increase.
* Perceptions of peers as competitors are decreasing; there is more trust.
* People are beginning to "let their guard down."
* There is less blaming of individuals and more focus on process.

Again, these comments should not be interpreted as suggesting a smooth and calm voyage. The sea is stormy and waves batter the transforming vessel from every point on the compass. For instance, follow-through on various recommendations sometimes falters, succumbing to "comfort" with the "way things are." Some people continue to voice honest convictions that TQL is simply this year's "fad," one more in a continuing train of "theories" that must be endured for awhile and then forgotten, e.g., MBO, quality circles, zero defects. Some people complain about being "burdened" with membership on "quality teams," while their "real" work founders. Others doubt "theories" pointing to processes when, in the "real" world, "...I get it in the neck."

These contrasting events only serve to illustrate the fact that transforming the way organizations manage themselves is a human drama. Attempts to reduce the effort to simplistic linear models are futile. Throughout their association, SUDA and Nemesis have strived to address the intellectual, emotional and conscience-based aspects of behavioral change.

A SAMPLING OF SPECIFIC NEMESIS TEAMING ACCOMPLISHMENTS

A list of several Nemesis formal teaming and process management accomplishments is attached in Appendix One. Appendix Two outlines some of Dr. Shuster's evolving axioms and principles of management transformation.

This section summarizes a selected number of specific transforming accomplishments reflecting both direct, and indirect, influences of the SUDA/Nemesis working association. Principles underlying these experiences are discussed in the two attached appendices. There are several existing formal models for teaming. For instance, a number of Nemesis personnel are certified facilitators in the Kepner-Tregoe teaming methodology. And, literally hundreds of books and articles provide details of brainstorming, Nominal Group Technique, cause-effect analysis, Pareto Analysis, statistical methods, and numerous other techniques. Dr. Shuster's book describing his teaming Process for Innovation and Consensus (PIC) is widely distributed throughout the Navy community, and the PIC was used in the Nemesis teams that he personally facilitated.

Example 1: Productivity Improvement Idea Process (PIIP), 1987-88.

A survey indicated that roughly one half of all Station personnel could recall personally creating and using at least one device, technique or idea to make their job easier, more effective or

satisfying. But, no more than six percent of them admitted to sharing those ideas with anyone else. The Station Engineering Directorate sponsored what was then called a Quality Action Team (QAT) to first, devise a user friendly method for people to submit innovative ideas, and second, to ensure that the ideas were shared throughout the entire community. Dr. Shuster facilitated the team for a year, with one interruption of about four months.

Membership spanned the entire Station. Therefore, some of the 14 members were virtual strangers, representing divisions that sometimes viewed each other with mutual hostility. Initial attitudes typically ranged from interested, through doubtful to cynical. Personality types also varied. There were two constants. First, everyone wanted to "get on with it," to achieve "results fast." Second, they were all smart. They were both intelligent and "street wise."

Not only did they succeed in their mandate, but they also experienced profound changes in themselves. They bonded. It took a few months, but they did bond. When the team disbanded, they were different people. Even their cynicism about the prospect for real change throughout the bureaucracy was tinged with enhanced expectations. Working in an optimizing environment, let them see what was possible.

The PIIP went "on-line" approximately three months after their submittal of recommendations, and it survived for almost two years. Station culture was not yet ready to permanently sustain it. However, it had significant tangible results. Several hundred ideas were offered and shared, with traceable realized savings of over $1,000,000.00.

More significantly, this experience generated substantial interest in chartering more teams to address critical issues. These people helped set the tone for the future.

Example 2: Travel Reporting/Payment Process Improvement, 1989-90.

Nemesis provides "in-service" engineering and logistics expertise to the Fleet and to its sponsor, the Naval Sea Systems Command (NAVSEA). Therefore, Nemesis people travel...across the nation and around the world...sometimes to exotic locations or into the middle of oceans. Plans and itineraries often change without notice, both before and during trips.

Requisitions for trips must be made prior to departure, including reservations and partial funding. Reporting and final funding resolutions must be completed immediately after travelers return. Revisions must be made to both of these requirements during trips compelling quick action by travelers, their departments and personnel working in travel offices both on and off Station.

Valiant efforts by all concerned did not prevent significant untimely, incomplete, and inaccurate performances and deliveries (just as the theory of process variation predicts).

The Station Executive Officer, ultimately responsible for travel processes, contracted with Dr. Shuster to facilitate a Process Action Team (PAT) to improve the end-of-travel reporting portion of the process. The pre-travel portion would be addressed later. Travelers were particularly concerned about receiving final funding in time to pay off credit card charges before dunning

procedures could impact their personal credit standings. Everyone, however, recognized the need for substantial improvement in timeliness, completeness and accuracy.

The team succeeded. Travel service improved in most every desired aspect. But, the most startling change was, again, in the people themselves. Travelers had developed deep disdain for on-Station travel office personnel, anger at their off-Station counterparts, and a general sense of victimization and anger. One of the first people selected to participate was famous as an articulate, outspoken angry traveling engineer. His initial attitude toward participation was little short of hostile. He openly expected little more than new directives and a future filled with more of the same. When he saw that everyone involved in the process, on and off Station, was represented, including critical decision makers, his attitude softened. When he saw that the PIC enabled open innovation and consensus, he radically changed. Everyone changed. And, he became the titular leader of the group, working tirelessly and independently to enhance its performance.

Using well defined theory and techniques, PAT members addressed and altered the process. Improvements were made. And follow-on teams were chartered to continue the improvement process. The pervasive increase in empathy, sensitivity and appreciation for all aspects of the travel process, and everyone involved was astounding. Individual addictive attitudes and behaviors truly changed. There was a cultural transformation in this small group of people that influenced all of their future Nemesis associations.

A follow-on team convened in 1991, facilitated by Station personnel, to improve the pre-travel portion of the process. Again, improvements were recommended and implemented.

Example 3: Improvement of Delivery Order Process, 1991

Delivery orders are requests for specific work to be done on a general contract already owned by one or more contractors. Engineers or logisticians prepare a Statement of Work (SOW) and requesting documentation, and send it to the contracts department. Contracts forwards the order to the outside vendor. The vendor responds. When all paperwork conforms to requirements, and when everyone agrees with the level of effort and pricing, the work begins.

Both engineers and contracting officers agreed that the delivery order process required improvement, most especially in the area of engineering/contracting liaison. Nothing is more pervasive in modern bureaucracies than the tendency to build barriers against communication between blocks on organization charts. This parochialism generates indifference, disinformation, hostility and process paralysis. It is a prime example of what Dr. Deming calls "sub-optimization."

This carefully selected group represented key participants from both engineering and contracts. From the start, a sense of their separateness was evident. Using the PIC, Dr. Shuster facilitated them through 15 sessions; four hours per session. Some meetings were stormy, others more placid. But, progress was made. Numerous recommendations were generated, along with careful

analyses of their potential consequences, if implemented. A subgroup formed to see to their implementation.

There is little question that individual members became more sensitive and empathic to the perspectives of colleagues in other departments. However, the barriers did not fall in the larger sense. They did tilt! And their foundations are certainly less firmly rooted. Defining culture as; "The summation of individual habitual attitudes and behavior," Dr. Shuster observed to them that habits are addictive; and that withdrawal from addictions is a long and painful process. But, this group had taken giant steps; first in facing the issue, and second, in resolving many of its effects. Subgroups continue their work to improve this process.

Example 4: Engineering/Logistics Directorates Barriers, 1991.

Nemesis line codes are divided into two primary directorates; engineering and logistics. The former is approximately twice the size of the latter, and enjoys a somewhat larger sense of prestige in the minds of many people. Their position in the contracting and funding processes also tends to favor them in allocating work and making some decisions. Again, barriers between the two groups became a long and pervasive obstacle; buried deep within the psyches of individuals.

It should be noted again that this barrier syndrome is a primary characteristic of modern bureaucracies. Economic and industrial sectors do not differ in this matter. It afflicts private, public, military, civilian, manufacturing, service, and knowledge-based organizations. Just as the theory of process variation suggests, this tendency grows out of the complex and often uncertain designs of organizational processes. Little wonder then, that it overwhelms people caught in local (and sometimes isolated) strands of its sticky web.

Therefore, it is essential for people to realize that when they "feel" helpless in the face of forces seemingly beyond their single control, it is because they "are" helpless in that respect. Only when they join with others to "rediscover" the process itself, will they gain the power to control their corporate lives. Everyone must understand that the issue is not about bad people doing bad things. It is about good people, locked in bad situations often beyond their individual control.

This team convened to change the "age old" barriers that divided them; and had, as yet, defied correction. Again, 15 (four hour) tumultuous sessions were conducted, using the PIC. Careful analysis generated numerous recommendations, including consequence analyses. Again, the barriers did not fall, but they did teeter. Some recommendations did become a part of daily work relationships. Mutual empathy did increase in sectors of each directorate. The group's efforts represented a major step forward in the transforming journey. They displayed great constancy of purpose throughout the emotionally wrenching experience. And, their work paid off; both in short and long term benefits.

Example 5: Recognition PAT, 1991.

Recognition and appraisal methods are continuing targets of criticism. Are they "fair," are they "objective," do they hurt more people than they honor? These are typical questions raised across organizations. Nemesis is no exception. Two basic questions seemed to be most on the minds of people. first, can we improve the appraisal system, that is, the process for periodically evaluating and ranking individual performance? Second, can we improve the way we reward people for outstanding accomplishments? The convened group decided to attack both of these issues under the more general heading of "recognition process."

This was a group of 22 members. It met for 14 (four hour) sessions, again using the PIC. Substantial outside research aided the process. Navy regulations were of paramount importance in the deliberations, for obvious reasons. Some very creative approaches were devised to both work within regulations and yet implement new recognition initiatives. A real insight gained by everyone was that regulations, by themselves, are not the "causes" of why certain things cannot be done. They are instead, "constraints" defining the limits within which independent decisions can be made by people who "choose for themselves" to do so. As such, regulations become positive forces for facilitating action, rather than negative chains binding choices.

Follow-on subgroups are continuing implementation efforts for several of the group's recommendations, and some processes have already been changed.

Example 6: Informal Teaming, 1985 - Present.

Teaming is not simply a process for conducting meetings. According to Dr. Shuster, it occurs whenever two or more people are communicating in an environment of "innovation" and "consensus." Such an atmosphere is called an "Enabling Environment," defined in Appendix Two. Innovation means intellectual liberation, such that each person can say whatever he/she wishes to say, and can listen to (and consider) whatever anyone else says. The unusual and the "absurd" are cherished in such an environment. Consensus means that there is 100% agreement on all decisions...majority and minority divisions are resolved. Such conditions are seen as utopian and unnecessary by some people. They are not utopian. Processes such as the PIC operationalize them into very practical realities. They are necessary because they operationalize Dr. Deming's "optimized systems."

Dozens of such informal teaming successes are a matter of record across Nemesis. Dr. Shuster personally facilitated a number of them. One engineering department in particular substantially improved many of its ship systems overhaul procedures by teaming individuals who previously worked at odds with each other. A logistics branch comprised of people, who had worked with each other for many years, teamed because they shared a visceral feeling that their performance and deliveries were good, but could be much better. What they discovered about themselves shocked them. They uncovered redundant methods, twisted priorities, unsuspected wrong turns, good results that went unrecognized, and relationships about which they were not conscious. They radically changed their fundamental processes, with spectacular results in both performance and bottom line results.

An engineering division had been struggling for several years over technical, organizational and personal problems arising from their need to travel and split up resources for long periods of time. They had devised six solutions to the issues, but could not come to equitable consensus on them. In one four hour teaming session they discovered a seventh solution, came to 100% consensus on two of them, and resolved the painful issue.

Numerous departments, divisions and offices have attended teaming retreats with substantial benefits. The single most difficult obstacle to long term success of such retreats is that the press of events, after the retreat, is used as an excuse to prevent implementation of retreat recommendations. One department held a second retreat to face that issue...and resolved it. They chose to overcome the "press of events," demanded constancy of purpose from themselves, and implemented changes.

SUMMARY

When teaming and process management become part of one's daily worklife, and are imbued in corporate processes, real cultural change takes place. Nemesis embarked on its never ending journey toward management transformation many years ago. Some personnel lead others in their progress. But, one need only to have been there to see events that only a few years ago would have seemed impossible. Station executives are now teaching some of the formal TQL courses, a task that was earlier left to contractors and specialized personnel. One can overhear conversations peppered with the language, theories and methods of management transformation. Formal teaming is more focused on critical issues of common interest. Informal teaming sprouts up everywhere. Process variation is more commonly understood, and statistical practices appreciated. A Process Improvement Measurement (PIM) effort has taken on widespread interest, including formal training on measurement.

Nemesis and its contractors have formed an official council, that meets periodically to hear distinguished speakers and promote management transformation throughout participant organizations. Substantial initiatives have been taken in both the public and private sectors of its membership.

Dr. Deming challenges vendors to see their customers as part of their own processes. Nemesis and its contractors have taken giant leaps in that direction by seizing many small accumulating steps over years of determined effort.

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APPENDIX ONE
LIST OF SELECTED PHD NSWC FORMAL TEAMING EFFORTS

This list of selected Nemesis formal Process Action Teams (PAT) indicates the range of topics and personnel involvement over recent years. It is a microcosm of the energy that has been devoted to service distinction and continuous process improvement.

1. Billing cycle time improvement
2. Logistics shipping time improvement
3. Logistics five step procurement concept
4. Establish Productivity Index Report (PIR), to improve quality of contractor evaluations
5. Develop and implement automated message processing system using "MTF Editor."
6. Logistics AIS documentation improvement
7. Administrative Officer/Program Analyst roles clarification in maintenance management
8. Engineering/Logistics Directorates barriers investigation
9. Facilities Trouble Desk process improvement
10. Minimize hazardous material and waste
11. Engineering Code 4T00, MK 86, overhaul system improvement
12. PHS&T Center, Earle, N.J. to PHD NSWC realignment proposal
13. Logistics departments removal of waste and barriers to high quality correspondence and efficient office operation
14. PHD NSWC/NAVSEA improvement of reporting of unsatisfactory material on hardware
15. Improve PHD NSWC recognition process
16. Engineering Combat Systems Department standardization of CSAM

17. Engineering/Logistics/Contracts improvement of delivery order process

18. Travel order process improvement

19. Incoming messages process improvement

APPENDIX TWO
SELECTED SUDA AXIOMS AND PRINCIPLES OF MANAGEMENT TRANSFORMATION

SUDA approaches management transformation from a comprehensive set of definitions, axioms, principles and practices; derived from many years of research, teaching and experience. This appendix offers a selected number of these ideas.

A. DEFINITIONS

1. MANAGEMENT: The study of "...the way we do the things we do," i.e., the study of "process."
2. MANAGEMENT TRANSFORMATION: The study of "...the way we improve management.

B. SELECTED AXIOMS

1. Groups do not act, people do.
2. No one can change another person's mind, but we can place others in an environment that enables them to choose to change their own minds.

3a. Obstacles are imposed upon us and, therefore, are not a matter of personal choice.
b. Our responses to obstacles are generated within us and, therefore, are a matter of personal choice.

4a. Every human organization is an "organic" system, composed of integrated interdependent individuals, such that each influences, and is influenced by, all.
b. The healthiest organizations are those whose individuals are "bonded" into organic communities that "optimize the system."

5a. People are disposed to resist changing individual habitual attitudes and behavior, and collective norms.
b. Individual habitual attitudes and behavior are addictive.
c. People will not change until they are psychologically ready to withdraw from their addictions.
d. Purposeful action is required to enable people to become psychologically ready and, themselves, act to change.
e. Unlearning inappropriate behaviors is often more difficult than learning appropriate counterparts.

6. Imagination is often more important than knowledge.
7. Workable theory is empirical theory.
8. People are creatures of integrity.
9. No one can delegate involvement.
10. Processes are abstractions; rendered operational only by individual actions.

C. ULTIMATE END AND MEANS OF MANAGEMENT TRANSFORMATION

1. Total customer satisfaction; meaning ecstatic delight.
2. Totally satisfied customers:
 a. Rave about the vendor, publicly and privately.

b. Come back for more business.
c. Bring new customers.
d. Invent reasons to spend time with, and confide in, the vendor.

3. Secret to totally satisfying customers is to always give them more than they expect.
4. Secret to giving them more than they expect is to practice "empathic management."
 a. View things from the customers' perspective, needs and desires.
 b. Think in terms of totally satisfying the customer's customer.
5. Surest way to totally satisfy external customers is to totally satisfy internal customers.
6. Surest way to totally satisfy internal customers is to:
 a. Create, nurture and sustain an Enabling Environment.
 b. Provide people with necessary and sufficient management philosophy, theories, and practices.
7. In an Enabling Environment people feel safe enough to make themselves vulnerable, and free enough to express, and act in accordance with, their own ideas; rather than react to external directives.
 a. An Enabling Environment:
 1. Liberates intellects.
 2. Empowers people to act in accordance with their own ideas.
 3. Allows optimizing of the organic community.
 4. Drives out fear of failure.
 5. Embraces, nurtures and cherishes risk, change and failure.
 6. Inspires joy.
8. Transforming Disciplines of Knowledge:
 a. Cultural Change: Altering the summation of individual habitual attitudes and behavior.
 b. Teaming: Ensuring universal participation by enabling individual innovation and collective consensus.
 c. Process Management: Ensuring product/service uniformity, by controlling process variation.
9. Transforming Levels of Analysis:
 a. Philosophy: Set of prescriptive universal transcendent management principles.
 b. Theory: Set of rigorous, empirically verifiable, management concepts.
 c. Technology: Collection of techniques for verifying and conducting theoretically prescribed management practices.

D. A WORKING DEFINITION OF MANAGEMENT TRANSFORMATION

Management transformation is a management philosophy that inspires and commits every individual to visibly and actively participate in the development, nurturing and sustaining of a working culture that pursues the ethic of total satisfaction of all customers, through dedication to continuous process performance improvement.

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Implementing TQM Takes Time and Patience

Thomas C. Staab

Director, Total Quality Management Office

Defense Finance and Accounting Service

One of the hardest lessons that all associates at the Defense Finance and Accounting Service (DFAS) Kansas City Center have learned is that implementing a Total Quality Management process takes time and patience. Management would like to see results quickly for several reasons - recapturing initial investment, cost savings, and improved morale to name a few. The associates are anxious to participate because finally someone is listening to their ideas. Everyone had to learn to focus on the four pillars of quality - Customer Focus, Empowerment, Teamwork, and Continuous Improvement.

Background

The Defense Finance and Accounting Service (DFAS), was established on January 15, 1991 to standardize finance and accounting policies, procedures, systems, and operations across the Department of Defense (DoD). On January 15th it assumed the assets of the Finance and Accounting Centers for the United States Air Force, Navy, Army, and Marine Corps, and the Defense Logistics Agency. It is designated as the official accounting agent for the Department of Defense and is committed to providing its customers with real-time quality financial management information, accounting and payment services at reduced cost.

The Kansas City Center is one of five DFAS centers and provides pay support to 200,000 active duty Marines, 95,000 retirees, 43,000 reservists and 6,000 annuitants. One of its additional functions is to support almost 300 DoD Activities (located throughout the US) in payment of approximately 110,000 invoices annually to commercial vendors.

The Kansas City Center's Total Quality Management (TQM) initiative, implemented in 1991, is an important element in the attainment of the goal to provide our customers with excellence in the quality of our services and information.

Implementation Planning

Planning for the TQM process commenced with seven objectives.

- Increase customer satisfaction
- Enhance the quality of services or products
- Improve work processes

- Encourage more efficient teamwork
- Promote employee involvement
- Increase employee capability to analyze and improve work processes
- Improve communications within the organization.

The top level management at DFAS Kansas City also realized that an organizational change in paradigms was required and that it would not be easy.

The new paradigm would have to replace the "way its always been" thinking and that would meet resistance. People were comfortable with the "old way". Managers and associates were expected to take on new roles - leaders and partners. There was the lingering doubt in the back of their minds that the other party did not have the sincerity to stick with the change. This would require the continuing task of ensuring that a positive environment for the change was nurtured. At the same time, everyone must be made to realize that their efforts were for the betterment of their work and their organization. Simultaneously, the fear that they are working themselves out of a job must be alleviated. This was a tall order, but it could be accomplished by taking a planned approach.

One of the keys to the success of any TQM process is the support of top management and the local union. The Kansas City Center has both. It was the decision of top management to implement TQM and they showed their commitment by providing the necessary resources. American Federation of Government Employees, Local 2904, has been involved with the TQM process from the earliest stages of implementation. They have a full voting member on each of the TQM management boards (Quality Council, Quality Steering Groups, and/or Quality Boards). The actions of the Center Director and his staff demonstrate their whole hearted support. One of the ways their support is demonstrated is by their participation on TQM management boards plus special TQM task teams.

The decision on whether to use outside consultants was made early. After determining what needed to be accomplished, what services a consultant could provide and evaluating the in-house capabilities we decided not to use outside consultants. That decision has proved correct for the DFAS Kansas City Center. Using in-house resources took a little longer, but it provided a broad base of involvement and high degree of ownership.

Once the decision was made to perform the implementation with local talent, a task force was formed. The task force leader had 23 years experience in the quality profession, plus a Master of Science degree in Quality Systems. He provided the six task force members (one of which was a union representative) with one week of training and they went to work.

The task force:

- Developed an implementation plan

- Developed a quality action plan
- Developed all training materials
- Selected and trained Facilitators
- Developed TQM policies and procedures
- Developed a detailed TQM structure.

Structure

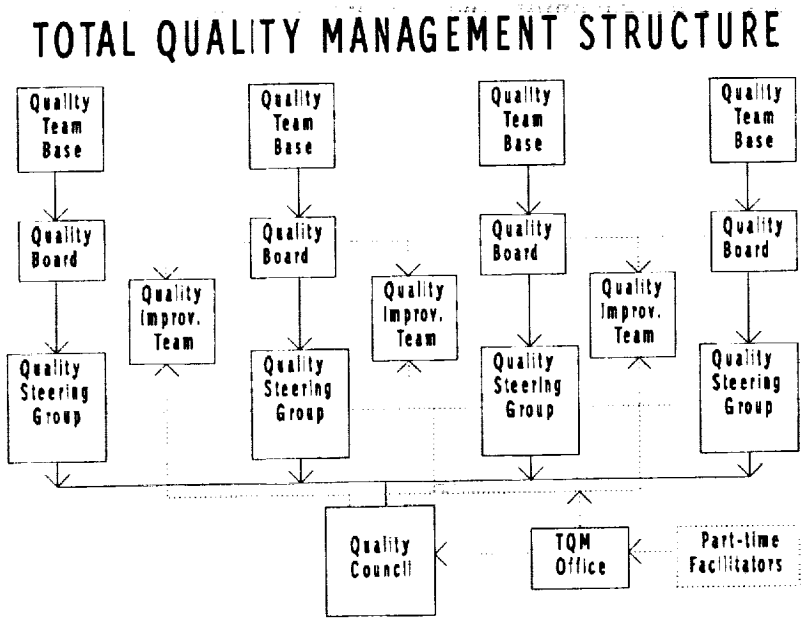


Figure 1

The development of the TQM structure shown in Figure 1 above was driven by an early decision to have every associate assigned to a Quality Team Base. They are the heart of the DFAS Kansas City TQM process. They are functionally aligned and meet together at least every two weeks. The goal is to improve processes through associate involvement at the lowest possible organizational level. The members determine the processes within their own work area they want to improve. They are provided a facilitator and elect their own leader and recorder. As they work through the Quality Improvement Cycle they are taught how to use new TQM tools, such as identifying their internal and external customers and suppliers, Pareto analysis, Deployment Flow Charting, and Cause and Effect diagraming.

Since September, 1991 the Quality Team Bases have successfully improved seven processes. Two examples of processes improved are:

- reducing the time to prepare and send a message to the field from 8-15 days to 24 hours,

- and eliminating duplicate efforts between two organizational units.

All seven successes could be resolved by a Quality Team Base within one functional entity. If it is determined that the process crosses functional lines, then a cross-functional Quality Improvement Team is formed.

A Quality Improvement Team (QIT) can be formed by any of the TQM management boards. Approval for implementation can also be made at the lowest appropriate level, but disapproval of either Quality Team Base or Quality Improvement Team recommendations can only be made by the Quality Council. The Quality Council has not disapproved a recommendation in the nine months since the Quality Team Bases have been functioning.

All management and union officials and all associates have received at least two days of formal classroom TQM training. In addition, twenty facilitators were selected and received ten days of additional training. The training was presented by Total Quality Management Office personnel. Besides providing TQM training they are responsible for:

- Serving as the focal point for TQM
- Serving as the TQM information center
- Coordinating all TQM activities
- Providing TQM expertise and resources
- Providing or assigning facilitators.

Currently the TQM Office reports to the Center Director. This has been very successful, but October 1, 1992 it will be placed in the Human Resources Directorate. This is the result of the desire by DFAS headquarters to have all five centers aligned in a standardized organization structure. There is no reason to believe that this alignment will not work, since the TQM Office will still have direct access to the Center Director.

TQM Data Collection

Collection of data on the TQM process is important. It is the historical record that allows an organization to judge its progress. Baseline data of the quality of products and services before implementation lets the organization know its starting point. Subsequent evaluation will be measured against this baseline. The data will be very helpful if the organization ever decides to apply for one of the quality awards - either the Malcolm Baldrige National Quality Award for private industry or the Quality Prototype Award for Federal Agencies. The requirements for both of these awards are very similar, so the requirements for either one can be used for self-assessment.

Recognition

As a way of saying "Thank you" to teams for their efforts, a committee of associates and Quality Council members developed a TQM Recognition Program. There are two types of recognition

awards, team awards (gold, silver and bronze) and customer service. The level of non-monetary recognition received by each team member is based on meeting pre-established criteria.

Lessons Learned

The TQM process at Kansas City has been successful so far. The desire to be further down the road is strong, but success takes time and patience. The initial planning and training was accomplished in a planned step-by-step approach that took just over one year. Benchmarking against organizations that had rushed the process showed that they usually had to suspend operations while they went back to accomplish some of the detailed planning. We feel that our approach has been very successful and are convinced that resisting the urge to forge ahead with haste has paid significant dividends.

A formal agreement with the union should be negotiated as soon as possible. Prior benchmarking against another Federal agency, that has an award winning TQM process, showed that they had to negotiate an agreement with their union after implementation. The Kansas City Center is in the process of negotiating an agreement on TQM with AFGE Local 2904. The timing of such an agreement will depend on each activity, but should be accomplished early in the process.

Management should have a list of processes, made up prior to implementation, that they would like for either Quality Team Bases or Quality Improvement Teams to study. This would help get more associates involved earlier. The natural evolutionary process taken by the Kansas City Center is working, but by having the early list the ideas would be flowing both from the top down and the bottom up. Management is currently preparing a list of processes they would like to have studied.

Conclusion

The DFAS Kansas City Center is always working toward continuous process improvement. The joy of success is infectious and more associates are becoming involved and "true believers" every day. It is felt that the early successes are only an indicator of the quantity and quality of process improvements still to come.

D Tools and Techniques for Total Quality Management Integration

This session will focus on three essential elements critical for your successful TQM integration. Specifically case studies of planning and organizing, tools and techniques, and expected results will be examined.

D1 Planning and Organizing for TQM Integration

This panel presents tools and techniques used by various organizations in planning and organizing processes to meet their business objectives.

John W. O'Neill, Deputy Director, Mission Operations, Lyndon B. Johnson Space Center, **"Strategic Planning as a Focus for Continuous Improvement."**

Philip R. Elder, Director, Total Quality Management, Rocketdyne Division, Rockwell International Corporation, **"Clear and Common Purpose - An Imperative of TQM Implementation."**

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Strategic Planning as a Focus for Continuous Improvement
A Case Study

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N94-13158

Introduction

What do most of the successful people and organizations in our world have in common? Instead of worrying about the future, they work to create it. They have a plan, or a vision of what they want to accomplish and they focus their efforts on success.

Strategic planning has been described as a disciplined, ongoing process to produce fundamental decisions and actions that shape what an organization is, what it does, and how it will respond to a changing environment. This case study discussion will evaluate the relationship between strategic planning and Total Quality Management (TQM), or continuous improvement, through the experience of the NASA Johnson Space Center in developing a strategy for the future. That experience clearly illustrates the value of strategic planning in setting the framework and establishing the overall thrust of continuous improvement initiatives. Equally significant, the fundamentals of a quality culture such as strong customer and supplier partnerships, participative involvement, open communications, and ownership were essential in overcoming the challenges inherent in the planning process. A reinforced management commitment to the quality culture was a clear, long-term benefit.

The Johnson Space Center: The Culture and the Challenge

The NASA Johnson Space Center (JSC) is located in Houston, Texas. JSC is the NASA Center most clearly associated with human space-flight development and operations. The JSC team is made up of approximately 3600 NASA employees and more than 13,000 contractor personnel. JSC's primary mission is the expansion of human presence in space through exploration and utilization for the benefit of all. This is accomplished by developing and maintaining the technologies and capabilities which are essential to building and operating human space vehicles for exploration of the solar system. As a Federal Government field center, JSC is somewhat comparable to a subsidiary for a large corporation. We are geographically

separated, have a specific business focus, and are somewhat autonomous in day-to-day operations, although we must pursue the direction of NASA Headquarters, the Executive Branch, and the Congress.

The JSC culture has been built upon the foundation of leading the Nation's human space flight activities emphasizing safety in space and on the ground, dedication to mission success, and working to reduce the cost of space operations. With this rich history, the management of JSC still faces a crisis. As noted by most leading experts, a sense of crisis can contribute to a fertile environment for the acceptance of TQM. This was indeed the case at JSC. The crisis or challenge facing the Center in building the future had four primary elements:

- Supporting multiple programs at various stages of development was still relatively new to us. We had to plan and implement our work using processes that were not one-program specific but could be applied across a range of activities, all of which supported our exploration focus.

- We were not sufficiently process oriented in our approach to programs. There was a tendency to continue using organizational interfaces, work methods, and support systems suited to the research and development phase, when more standardized processes would yield greater quality and efficiency.

- With increasing external pressures and numerous advisory groups and commissions offering recommended directions for the future, it was imperative that the Center establish its own clear vision and roadmap to the future. While external recommendations had to be considered, JSC needed a baseline for their evaluation.

- The resource base was shrinking. In the face of flat or declining budgets, we had to improve the way we did business and significantly reduce the cost of our programs, particularly the cost of long-term ownership and operations.

The potential of using continuous improvement fundamentals and tools to meet quality and cost reduction goals was clear. This, in turn, led us to focus on strategic planning as the means of articulating an overall framework and integrated set of goals and objectives that would serve as the long-term targets for process improvement initiatives.

Buying-In to the Process

In March of 1991, the JSC Senior Staff met to discuss the implementation of TQM at the Center. All agreed that the lack of an effective strategic planning process was the top business issue and that it was time for JSC to define how we intended to support NASA's future and the future of our Nation's Civil Space Program.

An updated plan was needed to help the Center focus its vision for the future, and to set a clear direction for the Center. A review was needed of JSC objectives, roles, responsibilities, and capabilities. The last strategic planning effort was conducted following the Challenger accident in 1986 and was appropriately oriented toward the recovery process and the re-establishment of program goals. Much had been accomplished since then, and significant issues of the future had become more clear.

From the onset, the JSC Center Director and senior management emphasized that the establishment of an ongoing planning process incorporating continuous improvement principles was as important as the issuance of a strategic plan. The past planning effort had not provided for any ongoing or follow-on strategic planning activity, nor had it involved all the senior management of the Center, thus limiting its "ownership" and implementation. To gain and retain ownership of the participants throughout the development of a strategic plan, the planning process itself was evolved through a participative effort. A Strategic Planning Subcommittee, reporting to the JSC Total Quality Steering Committee, was established. The Subcommittee, comprised of deputy directors from major line organizations, was supported by an in-house staff knowledgeable in strategic planning. The Subcommittee reviewed earlier planning efforts, researched other organization's processes, and brainstormed ideas for an effective process. The result was not a "textbook approach" to planning, but one that fits JSC's unique culture (refer to Figure 1).

Very early in the evolution of this approach, it was decided that strategic planning would drive tactical planning in all major organizations. Because of the challenge of setting an overall direction for the future, the Center strategic plan would respond to the JSC perception of Agency and national Civil Space objectives. The Strategic Plan was intended to state the Center's vision and mission as well as the goals and objectives necessary to actualize that vision. The statement of implementation objectives would be handled in subsequent implementation plans which would be prepared by each major organization at the Center.

Building Consensus on Goals and Objectives

Several strategic planning retreats involving all senior managers and deputies were held. While each retreat was designed to focus on a specific part of the planning process and provide a forum for the resolution of issues, the retreats really served another critical purpose. The retreats allowed the top managers to negotiate common perspectives of the Center, its objectives, and their organization's role in meeting them. The retreats not only allowed management to come to consensus on assumptions, but more importantly, to help identify the highest priority issues. Management examined where they thought the Center was today, and challenged whether that really was where they wanted it to be in the future. Throughout the retreat process, a variety of methods and tools were used to stimulate thought and discussion, including development of a helpful databook which outlined the

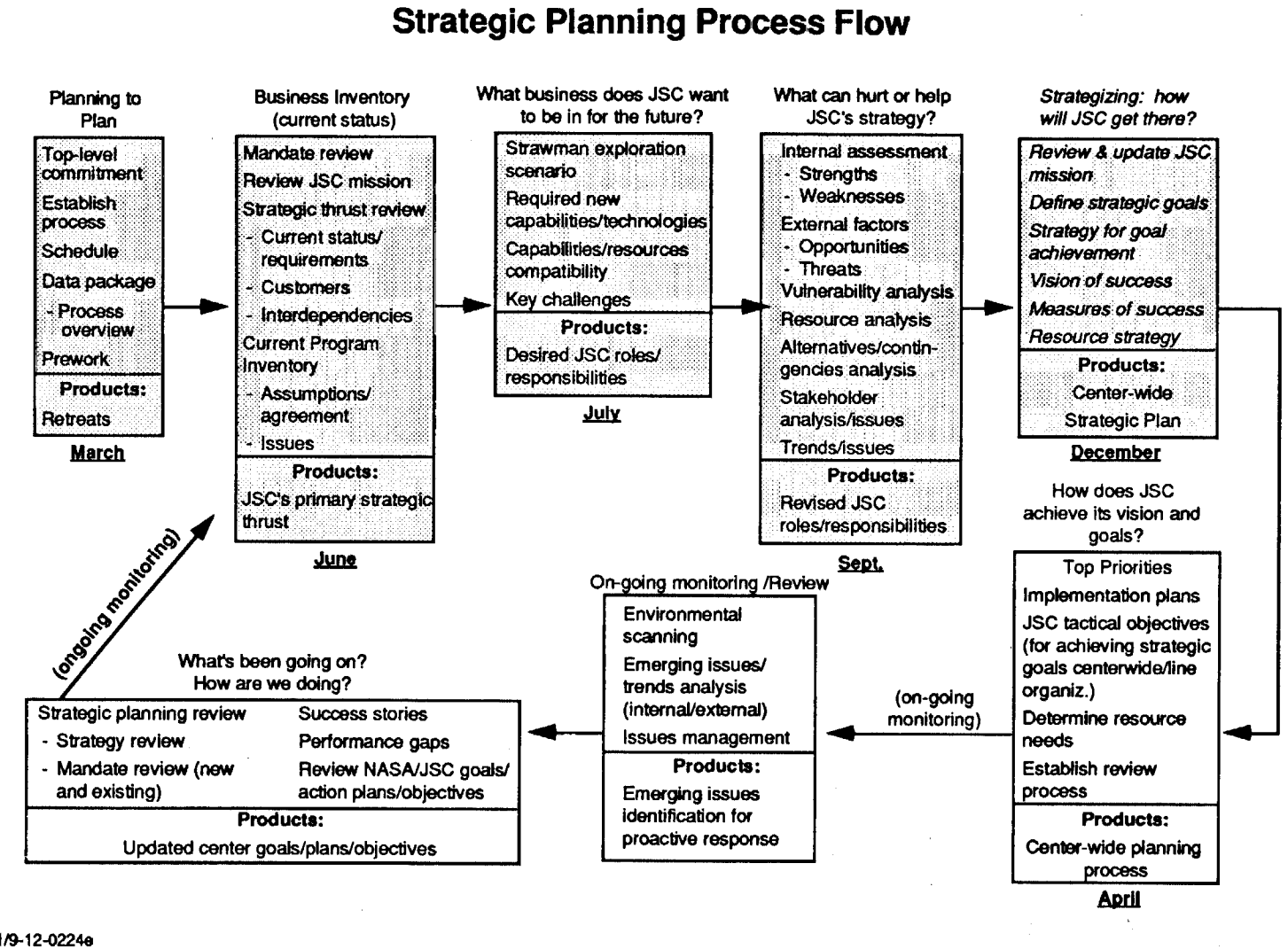


Figure 1.- Strategic planning process flow.

strategic planning process and presented strawman assessments of the external environment and issues. Homework, position briefs, small group break-out sessions, nominal group technique, and brainstorming were all utilized.

The process led to a redefinition of JSC's primary strategic mission. The Center, originally named the Manned Spacecraft Center, has always held "manned space flight" as its primary purpose. The conclusion was reached that JSC is really in the business of "human space exploration" which incorporates not only human space flight, but many of the other aspects of human space science and engineering that are required to achieve that broad and ambitious goal. Managers then identified how their organization's responsibilities fit into the overall exploration mission, and found the linkages between programs such as the Shuttle, the Space Station, and the Space Exploration Initiative (SEI).

In pursuing the space exploration mission, it was decided that an initial assessment of goals and objectives should be relatively unconstrained by resource and fiscal realities. This approach was driven by the axiom – nothing new and ambitious will be forthcoming if all the reasons why it cannot or should not be done are addressed first. To evaluate internal capabilities, desired Center roles, and the human resources and facilities necessary to carry out these responsibilities, we used a hypothetical scenario and timetable for an SEI which covered President Bush's mandate of a human return to the Moon to stay and the exploration of Mars. Then the vulnerabilities, external constraints, and the total funding requirements of the multi-program approach to Shuttle, Space Station, and SEI were assessed. Each center organization presented what resources such a scenario would require, what issues it would create, and new ways to do business that would be necessary to meet the scenario. When we compared the resources we needed in the "best of all possible worlds" with the funding we could realistically expect, senior management realized that new ways of doing business were essential if we were to achieve the Presidential mandates, and our own mission, for the future.

Developing the Plan

How to do business better became a major theme of the final Strategic Plan, which we developed using a Critical Design Review process similar to that of flight systems and, therefore, familiar to management. Our process included inputs from each directorate, and supporting analyses which were prepared by special teams of line managers and employees. "Experts" throughout the organization provided inputs and critiqued the plan as it was being developed. Also, we did not take an exclusively JSC focus in our planning efforts. A National Space Council representative and a NASA research center representative participated in some of our planning sessions. In the future, we would like to get other NASA centers involved so we can include ideas from these important customers and partners in our planning.

Pioneering Space Exploration: The JSC Strategy 1992, which is essentially a 5 to 10-year roadmap for the Center, was distributed to all JSC employees and contract organizations in January. Because an ongoing strategic planning effort is inherently dynamic, we are making changes as necessary when new conditions arise, such as the change of Administrators and the subsequent Red/Blue Team activities.

Positive Outcomes

What could well prove to be the most long-lasting positive impact of the strategic planning process was the recognition by senior management of the need for a formal, ongoing strategic planning and action management process at the Center to assure that resources are applied to those activities that best support our human space exploration mission. To this end, the Executive Council, made up of Senior Staff and chaired by the Center Director, was established as the decision-making body for TQM and strategic management. It makes resource allocation decisions and resolves any issues that arise with Plan implementation.

An important tool of the Executive Council is the JSC Strategic Filter, designed to assist in setting priorities and allocating resources between current projects and new activities, including major continuous improvement projects (refer to Figure 2). The filter criteria is designed to allow the Center to pursue those activities that are directly related to our mission and pass on those that do not fit within our defined future. The filter has two stages. First, the Executive Council determines if the proposed project fits our mission, roles, and strategy. If there is a strategic fit, the Executive Council looks at resource criteria in the second phase. If resources are available, the project can be pursued; if no resources are readily available, top management must decide if it is possible and desirable to invest the resources to do this activity - - to give up something else in order to do it. If so, we must step up to the necessary changes to meet it.

Commitment by top managers, especially the Center Director, has the two-fold effect of dynamic participation in the process and a level of common awareness that allows all participants to represent a unified JSC position in external arenas. Every director and deputy literally signed up for this plan (refer to Figure 3).

Education and improved communication among Senior Staff members are other positive outcomes of the strategic planning process. The planning retreats offered the first real opportunity for Senior Staff to openly and informally discuss concerns, issues and ideas. Each director provided insights about their department's roles, concerns, and direction that may not have been fully shared before. Although senior managers meet at least weekly to discuss Center business, these meetings do not provide the right impetus for brainstorming and idea generation. Several managers said this open interaction was most useful to them and recommended

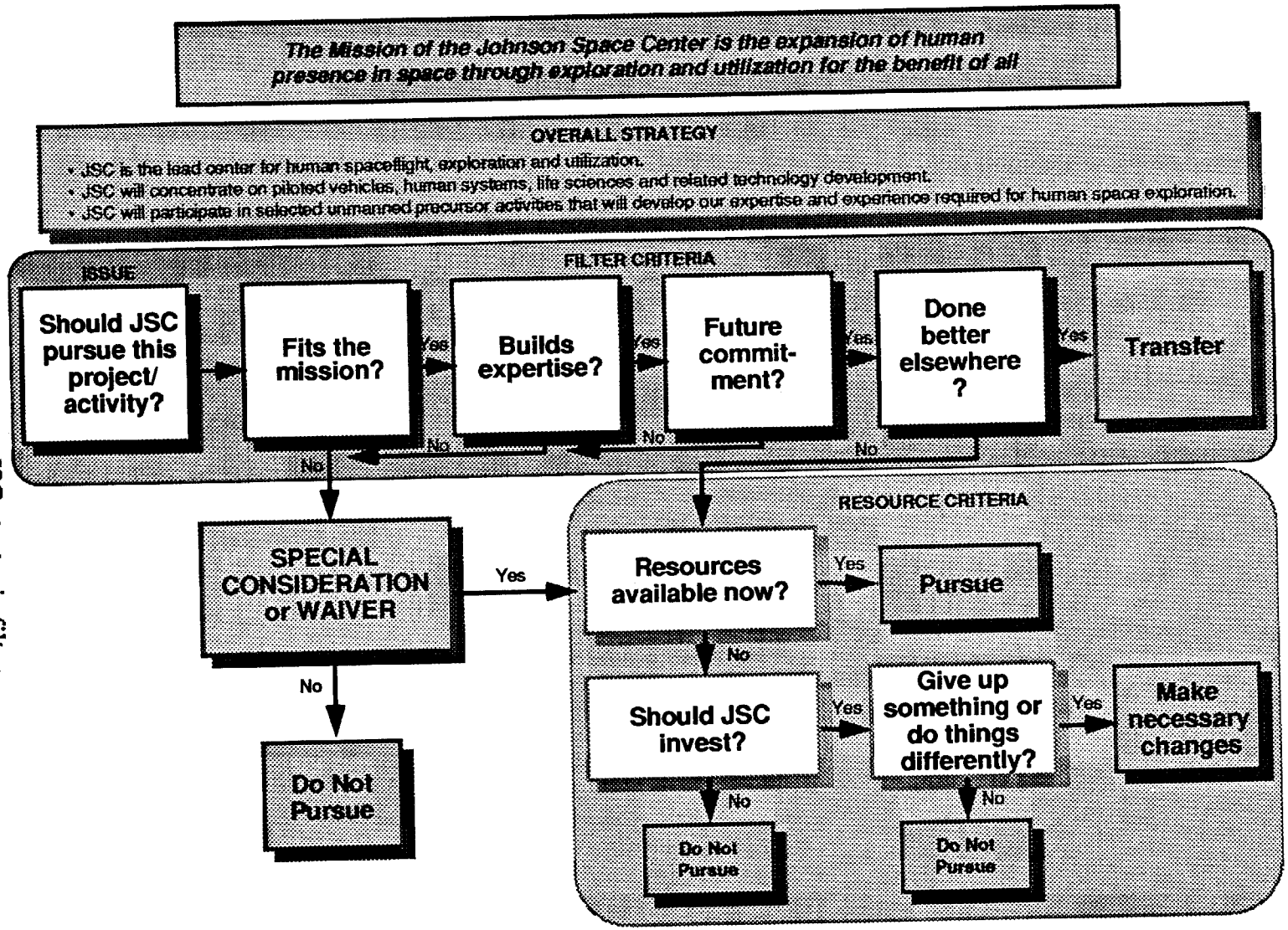


Figure 2.- JSC strategic filter.

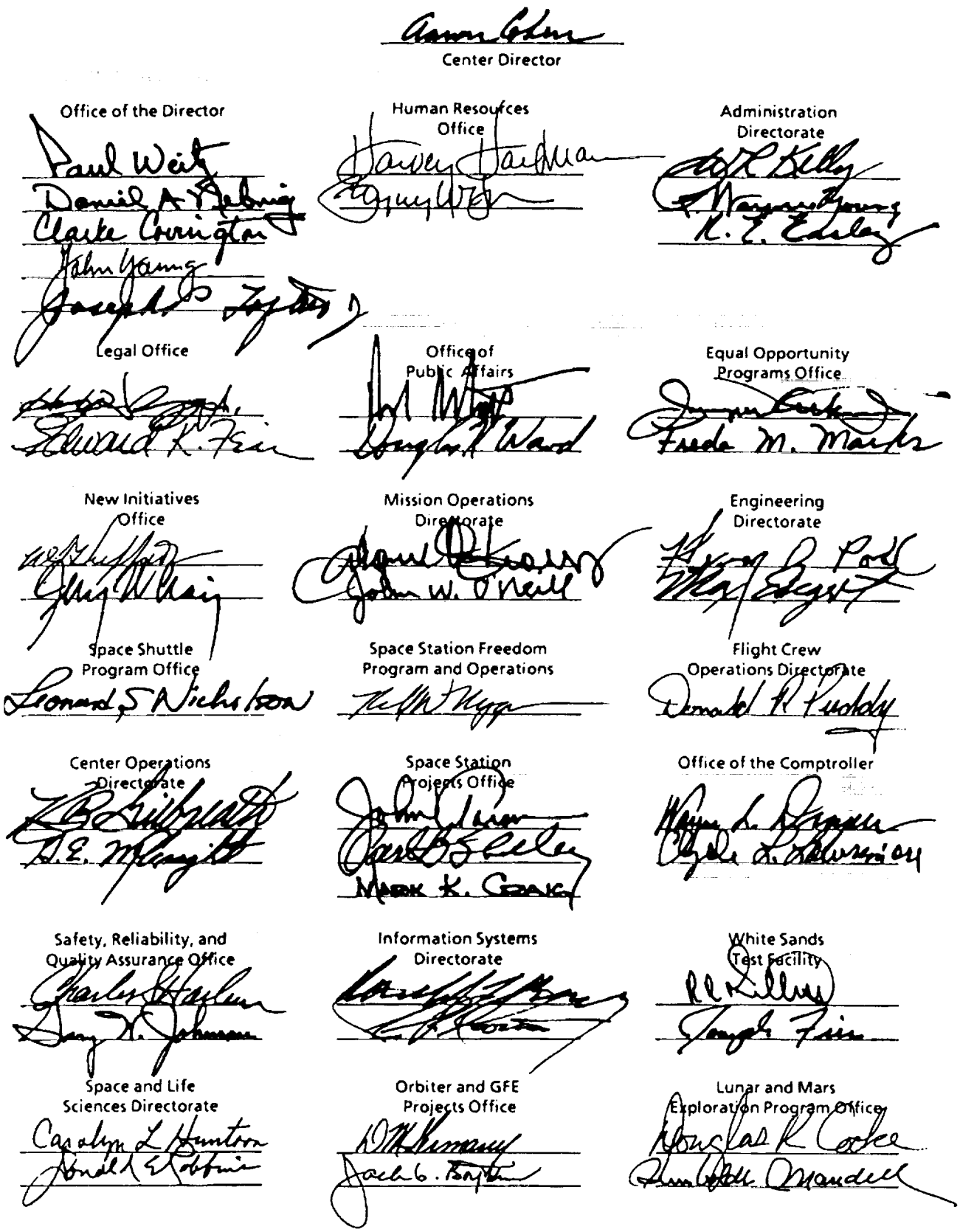


Figure 3.- Signature page.

that such informal sessions become a regular part of continuous improvement and planning.

Our experience demonstrated that strategic planning and continuous improvement must be accomplished together to be fully successful. The JSC strategic planning process increased the awareness by senior management of the need for continuous improvement in our administrative, program management, and operations management processes. The need to "do business better" has become a top management byword. The continued involvement of the Strategic Planning Subcommittee and Total Quality Steering Committee in the implementation of the Strategic Plan is another positive sign.

The strategic planning process was not only a unifying and useful tool for management, but also led to the honing of the skills of a small in-house strategic planning support staff. We looked to the project planners in our advanced projects organization and to facilitators from our Human Resources department to help develop and support a strategic planning process tailored to the Center's unique needs.

The skills and knowledge of the in-house support staff enabled much greater flexibility in the process. Rather than adhering to a specific "textbook" format, the planning team had the flexibility to make "mid-course corrections" as necessary to the planning process. These mid-course corrections were not looked upon by senior management as failures, but rather underscored the adaptability of strategic planning to any contingency. For example, mid-course corrections often were needed during retreats to resolve misunderstandings or to accommodate new thoughts or issues that developed.

Implementation

Each JSC organization is now in the process of developing an implementation plan that will provide the tactical strategies and measurable objectives for carrying out the 1992 JSC Strategic Plan over the next 3 years. Each organization has been encouraged to emphasize an inherent strategy of using TQM techniques, processes, and philosophies to achieve business efficiencies in all possible areas.

The implementation plans will contain the action steps, schedule, and cost and performance metrics necessary to communicate what we intend to accomplish and the means to measure our progress and success on a program and project-specific basis. Many questions surround the future of the NASA budget and the outcome of the Agency Red and Blue Team activities. We believe that we have developed a sufficiently flexible ongoing strategic planning process to allow us to respond to changes in policy and direction as they arise. The implementation plans will be in place in time for the beginning of a new cycle of strategic planning and the 1993 update of our Plan.

Lessons Learned

The path followed through the resulting strategic planning process reached the goal of coming up with a roadmap for JSC's future, but there were many challenges along the way.

Identification of major customer requirements for a public sector organization presents difficulties. A private sector company is usually designed with a marketing orientation and easily identified customers.

A large public sector organization like NASA finds its external environment, especially political stakeholders, changing rapidly. Public sector activities are also highly visible. This is especially true in NASA's case, with public scrunity of every space flight.

For JSC, defining a meaningful, realistic, and traceable set of customer requirements upon which to build a plan for the advocacy and support of NASA programs has been a formidable task. Is the customer the American taxpayer or their elected representatives? Or, are our customers the other government agencies, payload investigators, foreign countries and others for whom we fly missions? With our matrix organization, many internal customers exist, such as the programs and projects supported by the institution. Identifying the true customers is a major challenge, and TQM customer assessment techniques are being used to address this challenge as we enter Plan implementation.

Assessing the external environment also proved more difficult than anticipated. Our strategic planning databooks, given to each director and deputy, highlighted external issues, stakeholders and concerns. The managers felt comfortable reviewing external issues they dealt with on a regular basis such as Federal budget concerns. However, a thorough analysis of strengths/weaknesses/opportunities/ threats (SWOT), stakeholders, and other external vulnerabilities was not possible without extensive review of public policy and competing national priorities. An issues assessment action team has been formed to assess methods for developing a better understanding of our external environment so we could be more proactive toward emerging concerns and opportunities.

Implementation is often the most difficult part of the planning process and the place where most planning failures occur in both the public and private sectors. Detailed operational action plans that include cost, workforce and facility projections, milestones, and areas of concern must be developed. Managers must commit to action and necessary changes in their own organizations to meet the needs of the Center and Agency. The initial buy-in for the overall planning does not necessarily eliminate "turf" battles during implementation planning. The continuous improvement process provides a framework to help break down these barriers and build trust that will help develop our planning process over time.

We were slow implementing the Plan after publication. This allowed other pressing needs and external changes to supersede implementation. An important lesson learned is that implementation planning should immediately follow strategic plan development and must be considered a top priority of all management. In fact, implementation should begin before the planning is complete in areas where actions are clear.

Communication of the plan, strategies, purpose, meaning, and intent to all employees is vital. Line managers, in particular, need to be kept updated on the planning process so they can provide inputs as appropriate and have ownership. Employees must be aware that the strategic planning process takes time, that it is ongoing, and that they have a stake in the planning activities. A feedback mechanism must be provided so inputs can be reviewed by top management and updates incorporated where necessary in the process.

Future of JSC Strategic Planning

The process of setting new directions for NASA has begun with the Red/Blue Team activity. This will promote more coordination among JSC, Headquarters, and other NASA Centers in developing strategies for the future. Also, as more NASA organizations become involved in strategic planning, more networking, idea sharing, and joint problem solving occurs.

We have a process in place that has management acceptance. As implementation plans are developed, we are refining the strategic planning process. We are beginning the monitoring and evaluation phase, looking for internal or external changes that may impact the plan, looking for disconnects, and searching for ways of doing business better. With the Executive Council and filter process in place, we are assured of implementation and feedback to line organizations.

Strategic planning never ends. It should provide a focus for continuous improvement in all areas and benefit from the application of continuous improvement principles to the strategic planning process itself. We learn from doing, just as our NASA team learns from planning and carrying out a space mission:

> To plan a space flight, we must first understand the technical requirements and mission objectives. Contingency planning for anomalies is vital. Innovative procedures or hardware may be necessary to rescue a stranded satellite or perform a complicated on-orbit maneuver. Flight crews and controllers simulate every conceivable scenario, so they can handle and adapt to the demands of a hostile space environment. Flight plans are tested and reassessed up to launch time. Most crucial of all is building a team linking many

organizations and disciplines, who make the seemingly impossible happen.

Can planning the future of human space exploration be less?

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Clear and Common Purpose - An Imperative of TQM Implementation

Philip R. Elder, Director, Total Quality Management
Rocketdyne Division
Rockwell Internatonal Corporation

Paper not available for publication.

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D2 Successful Stories for Implementing System Level TQM/CI Tools

This panel will spotlight successful implementation of system level TQM tools (i.e. QFD, DOE, CQ, SPC and best practices). Presentations will include a quick overview of the tool, a discussion of the implementation strategy, and overview of the training approach, and some results and lessons learned.

Thomas J. McMaster, Vice President, Operations, AND **Timothy M. McClung**, Vice President, Engineering, Allied-Signal Aerospace Canada, **"The Power of Cross-Functional Teams in Driving Total Quality."**

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The Power of Cross-Functional Teams in Driving Total Quality.

T.M. (Tim) McClung, Vice President Engineering,
Allied-Signal Aerospace Canada

T.J. (Tom) McMaster, Vice President Operations,
Allied-Signal Aerospace Canada

INTRODUCTION

Garrett Canada, a Division of Allied-Signal Aerospace Canada, has been a member of the Canadian aerospace industry for 40 years. It was established in 1952 as a Montreal sales office for AiResearch Company of California. A repair and overhaul facility was established in Toronto in 1956. By 1961 Garrett Canada became a chartered corporate manufacturer of electronic temperature control systems for worldwide sales and distribution. Located in Toronto, Canada, Garrett Canada today has 1000 employees who design and manufacture advanced electronic thermal management systems for aerospace applications. Although Garrett Canada has always been a profitable division with leading market share, the changing and turbulent business environment and globalization of the aerospace industry has created new demands and challenges.

The marketplace is demanding faster introduction of new products, as well as shorter leadtimes for repairs and spares. It was recognised that reducing cycle times for new products and for ongoing production would not only satisfy our customers, it would also enhance our business performance through reduced inventories, lower past due, and more responsiveness to change.

It was evident that drastic step function changes were required if we were to maintain our position as a premier aerospace supplier.

THE CHALLENGE

The challenge was to convert a stable, somewhat slow-paced work environment with strong functional boundaries into a boundaryless world class team functioning in a total quality environment and focused on customer satisfaction.

Complete and uncompromised customer satisfaction has become our driving force, with Total Quality being our engine to continuously improve our processes and increase our speed.

MANAGING THE CHANGE

It was recognized that Total Quality begins at the top. The executive team has been revitalized to ensure that Garrett Canada remains a leader in its Total Quality initiatives. With highly charged leadership, we are on the road to becoming a world class company, able to respond to global competition effectively and profitably.

Building on our strength, energy was focused on revitalizing our key assets "our human resources", since we were addressing the issue of cultural change of the organization.

Our change philosophy was in alignment with our four business priorities:

- Meet our commitments
- Grow our Business
- Develop our People
- Simplify our Processes

Garrett Canada's primary business strategy has been focused on gaining competitive advantage on all three dimensions:

- Quality
- Speed (time)
- Cost

These priorities and business strategy have been stable for several years, and provide an anchor or focal point as we drive the cultural change through the organization. They also complement our Corporate Total Quality training program which focuses on:

- Customer satisfaction
- Process improvement
- People
- Act on fact

The Total Quality training program is being delivered to all Allied-Signal employees during 1992/93, and comprises of a four-day workshop. This training provides an awareness of the need for change, as well as the tools and methodology to execute the change. At Garrett Canada all 1000 employees will complete their training by the middle of 1993. The Total Quality training program is complementing our efforts to redefine the culture and behaviours of Garrett Canada.

IMPLEMENTING TOTAL QUALITY

Referring to the focus points of the Total Quality training program mentioned previously:

a) Customer Satisfaction

In 1991 we launched our Customer Advocate Program designed to provide Executive Management direct exposure to our customers. Key executive staff have been

assigned advocacy responsibilities for specific customers, for which they have to develop relationships with key individuals in their customers' organization such that they can provide valuable business contacts as well as make independent assessments of their customers' satisfaction ratings and feelings.

Metrics are being established for the five or so parameters which each customer deems to be most important to them, and which are indicative of our performance. These parameters are then charted in graph form, and are referred to as "5-Ups". An example of Garrett Canada's 5-Ups is shown below (see Figure 1).

These 5-Up charts are developed for both internal and external customers, and become the measure by which we evaluate our performance, and the measure by which we evaluate the impact of improvements made to our processes and operating methods.

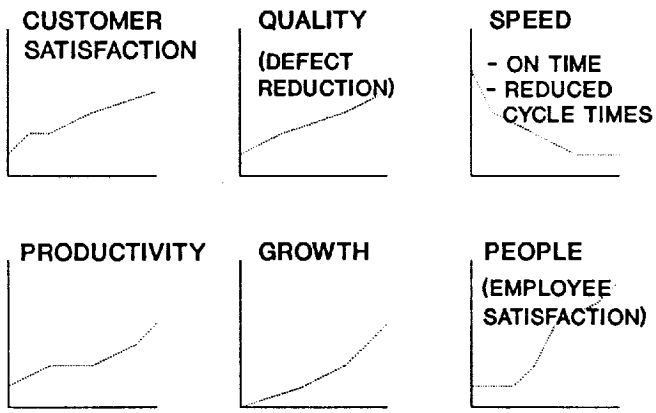


Figure 1 "5-Up" Charts

b) Process Improvement

A fundamental part of the Total Quality training is a nine-step Process Improvement/Problem Solving (PI/PS) Model. This provides a framework for improving the way we work. In the past, we have tended to fix symptoms of problems, with the result that the problem would recur, or worst still, the solution would give rise to a new set of problems. Problem solving has long been the bailiwick of specialist functions who often perform their tasks in isolation from the individuals affected by the problem. However, today's problems are predominantly complex, affecting many company functions. The need, therefore, is for a problem solving process which utilizes the stake holders and key players affecting, or affected by, the problem. This need gives rise to the importance of energizing the workforce to a level of motivation and commitment whereby the traditional bounds of job descriptions, "turf" issues, and Not Invented Here (NIH) syndrome, are no longer a factor. Employees must step beyond those bounds to improve their work processes and resolve problems thereby raising the company performance to a new high. The PI/PS model provides a common approach, consistency and thoroughness of

application which, when combined with our Total Quality training program, results in energized employees.

c) People

During 1991, two way employee communication was given a high priority. The introduction of biweekly INFO newsletters has increased employee awareness of the turbulent environment in which we are operating. The introduction of Special Recognition awards to multi-functional teams was a breakthrough and reinforces teamwork as a way of life at Garrett Canada. Weekly Employee Rap sessions with the president have opened up channels of communications. A Quality Day for key executives and managers encapsulates our determination to make Total Quality "real". Monthly presentations to all management and supervisory staff from the President ensure that business issues, competitive position, and operating results are communicated throughout the organization in a timely manner. The decision to deliver the four-day Total Quality training to each and every employee was made to ensure that all employees developed an understanding of the Total Quality process and the methodology, and were given the opportunity to develop their own capabilities and realize their potential. Training is given to natural work groups whenever possible, and incorporates their current problems as an integral part of the training material.

d) Act on fact

An extensive array of metrics has been introduced which reflect the performance of each function. Using a series of "5-Up Charts", each function, each department, and each individual is able to identify their customers, and the metrics which their customers deem to be important. These 5-Ups form the basis for measurement of progress of improvement, and the goals towards which the company and its constituents strive for. Identification of these 5-Ups, monitoring and follow-up of performance against them is fundamental to the success of our cross-functional teams. A system of metrics based on the flowdown of these 5-Ups was established to measure progress and to direct corrective action when required.

Our emphasis on Quality has not been limited to Engineering or Operations. Administrative functions have undergone significant reorientation to satisfy internal customers. Examples include Training, Human Resource Systems and improved Program Management Tools.

We believe the solution to changing the organization to focus on customer satisfaction in general, and speed in particular, is through the use of cross-functional teams and a combination of:

i) Process Improvement/Problem Solving Model,
ii) Total Quality Training,
iii) Clearly defined stretch goals, and
iv) Management support.

Total Quality efforts are being applied to our whole business process, from customer requirements through product design, supply management, manufacturing and customer support. This paper will focus on two major elements of our business process:

(a) customer requirements and product design - where we have implemented our Integrated Product Development Process to reduce the new product introduction cycle time, and

(b) supply management and manufacturing - where our Total Quality Teams are reducing operational cycle times.

INTEGRATED PRODUCT DEVELOPMENT PROCESS

BACKGROUND

Early in 1991, intense competition resulted in Garrett Canada accepting a new program contract which required us to establish product and engineering cost targets 25% lower than planned - a plan which was already aggressive. Working harder may have achieved a 5-10% savings but we had to find a way to work smarter. To reduce cycle time and corresponding costs we decided we would have to eliminate most of the sequential releases and builds of development hardware configurations. Each version of equipment would have to be as close to right as we could make it on the first pass. We could not tolerate the several rounds of downstream changes caused by factory inputs and misunderstood customer requirements. Our approach was to form teams to address each major area of engineering development, with members from all of the engineering disciplines involved in the design and definition of the new product. As well as project, design, manufacturing, quality assurance, test and customer service engineers, we also incorporated program management, contracts and sales members as appropriate. Our customer and key suppliers were also included in this process. This is the essence of concurrent or simultaneous engineering. We call these teams Design-Build Teams or DBT's. Cost targets for all major system components were established, and criteria were developed which allowed trade-off decisions between non-recurring costs and recurring labour, materials, and relevant overhead. This provided the teams with a more objective tool for design review product-cost decision-making.

GETTING STARTED

We were fortunate that our customer was also deploying their own integrated development process and, as a major supplier, we were invited to attend training courses at their facilities. We sent a small group of our key people to participate. This group became the core of our own project Design-Build Team and training facilitators for subsequent lower level Design-Build Teams.

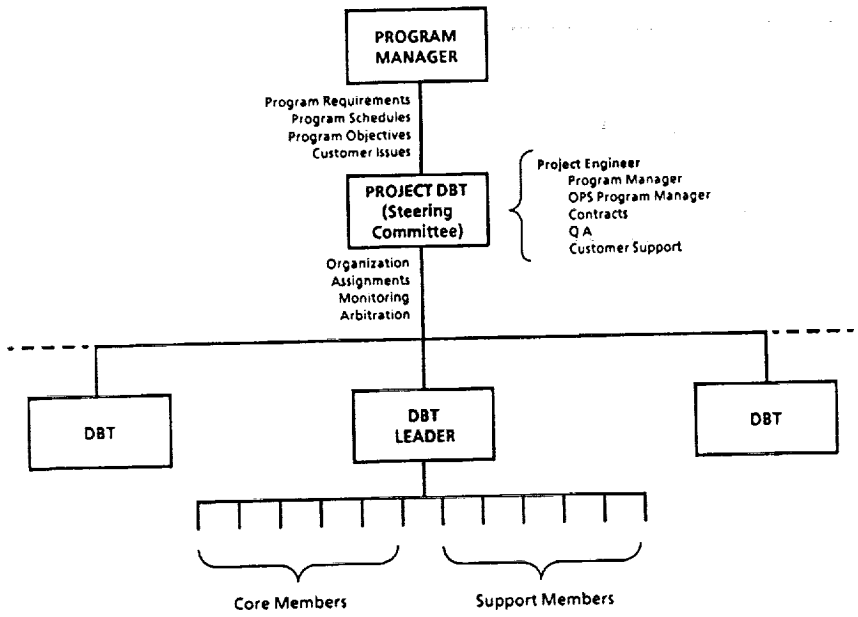


Figure 2 Design-Build Team Structure

Although a smaller project could operate with a single project DBT, the project we addressed involved a significant number of contributors. We divided the project into seven subsidiary DBT's for significant design activities, and assigned appropriate members from cross-functional disciplines. Core members would serve more-or-less full time on these teams, and support members would serve on several DBT's on a part time basis (see Figure 2). Once formed, the teams (both core and support members) were given eight (8) hours of training in two sessions. All teams were trained as a group in the overall process and underlying principles. These included DBT structure, team synergy, building consensus, and project goals. Subsequent to this, each individual team had separate training to help develop their own operating norms and goals (eg. meeting processes, roles and responsibilities, and setting detailed time-phased team goals and objectives).

In this mode of operation, Design-Build Team members operate in a matrix organization (see Figure 3). We are a medium size division which is called upon to support 10 to 20 new product development projects at various stages of completion, and provide continuing support for ongoing production products. This approach provides flexibility and optimum use of our engineering resources. Key to success in this process is the balancing of program and functional responsibilities by the DBT members. The program goals are focused on Cost, Schedule and Customer Specification Compliance. DBT members must also incorporate home department functional initiatives focused on departmental resource planning and strategic directions which address preferred technologies, automation, standardization and reuse. Success in this approach is founded upon training, individual accountability, enlightened, supportive functional managers and an overriding commitment to customer satisfaction.

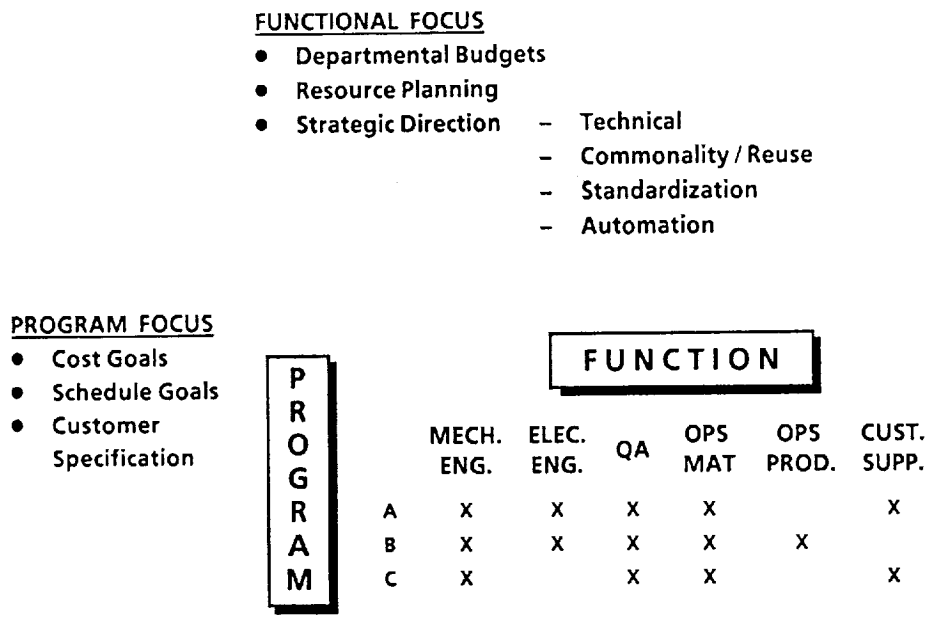


Figure 3 DBT Members have Matrix Responsibilities

EVOLUTION OF THE PROCESS

The Design-Build Teams have been operating for approximately eighteen (18) months. The Pilot Project is on schedule with all major customer milestones met. Development non-recurring costs are tracking the 25% reduction line and the current manufacturing product cost estimate is at 74% of its original value (see Figure 4). Both our customer and suppliers participated jointly in design studies and technical reviews. The program Critical Design Review was successfully completed this spring and the first production prototype units are being fabricated in our manufacturing new product cell - this cell being the result of a Total Quality team effort. Several other projects have also benefited from the manufacturing process reviews and test procedure development conducted in this dedicated facility.

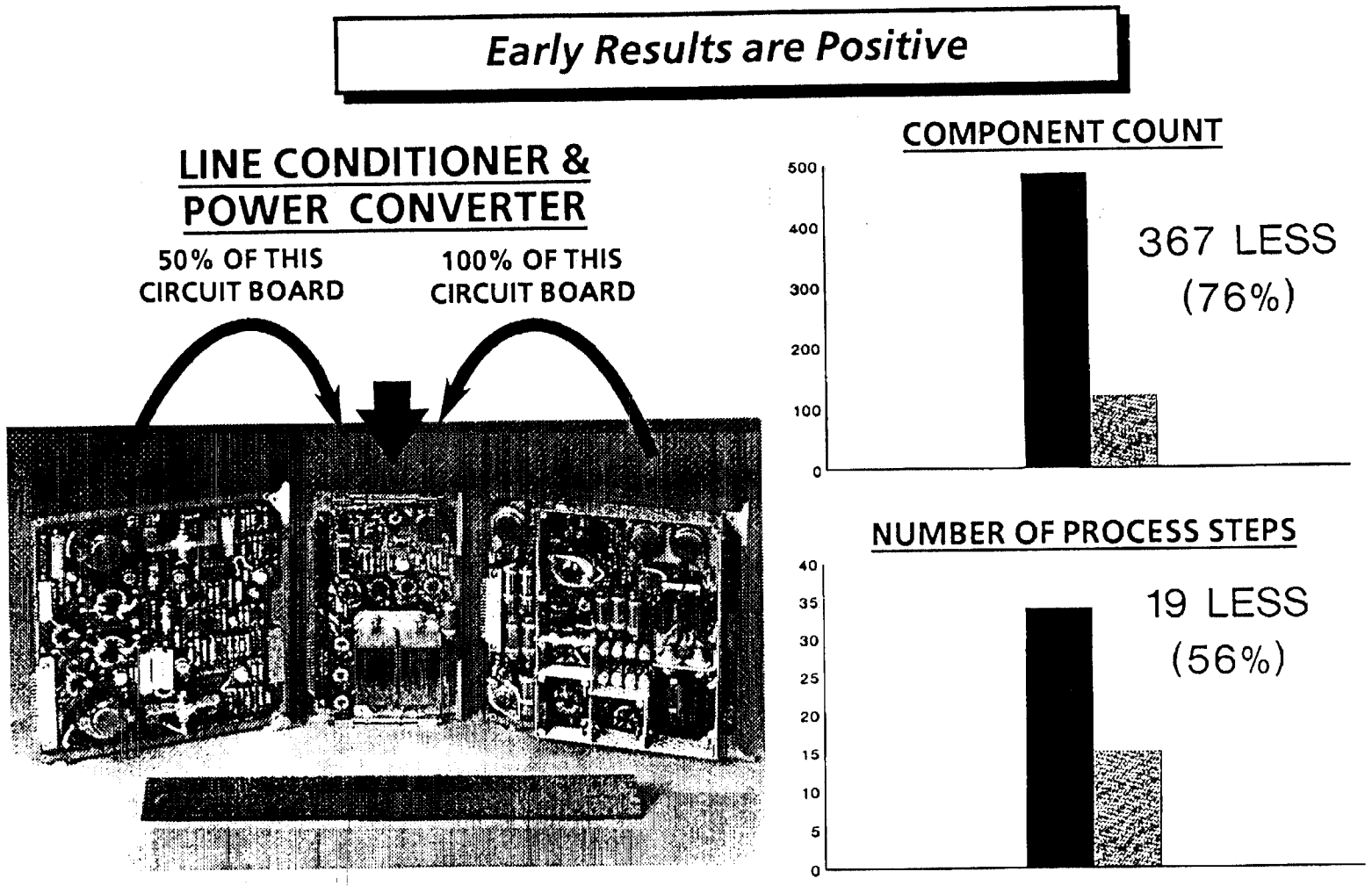


Figure 5 Power Converter Module

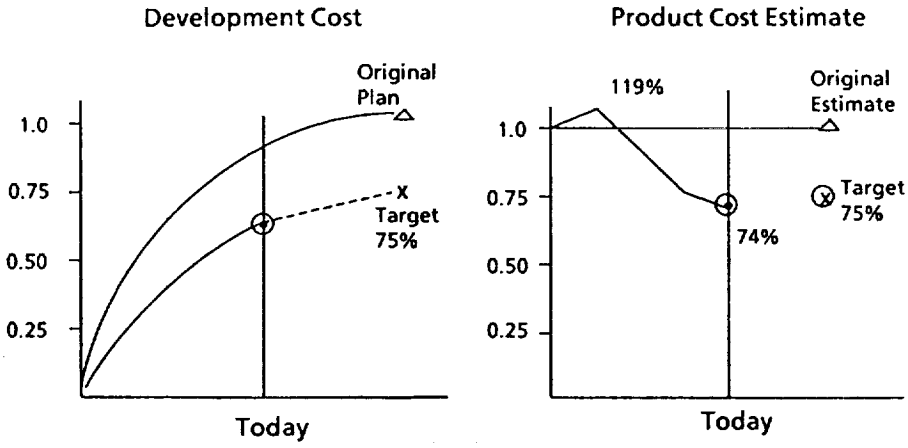


Figure 4 Project Cost Status

One of the early significant results of the approach was achieved by a sub-team which tackled the design of the Power Converter Module and involved the design engineer, a component engineer and purchasing representative as principals. They evolved a power converter design that eliminated one complete printed wiring board assembly, reduced the types and numbers of components required by 76% and manufacturing operations by 56% (see Figure 5). This design approach offered such significant savings that it has been back designed into several other existing products.

As the individual DBT's addressed their tasks, the only common process procedures they had to work with stemmed from their individual basic training. Each group evolved their own operating procedures and design review approaches. The project Design-Build Team Steering Committee provided a level of consistency and forum for the migration of best practices across the several subsidiary DBT's. Not all of the DBT's were equally successful. One team leader and team members changed at their own request due to dissatisfaction with their results and the process, and two other teams merged into a single team. The process was deemed to be of substantial benefit, due to the cost savings indicated by the pilot project, and perhaps more importantly by the fact that ad-hoc "Design-Build Teams" were beginning to perceive benefits and form themselves spontaneously on other development projects.

The evolution of the design-build process was planned following the Deming/Shewart Plan-Do-Check-Act (PDCA) improvement cycle (see Figure 6). As described in the preceding paragraphs the "check" portion of the cycle was indicating that the process was beneficial and the "act" portion of the cycle would require a review of lessons learned, development of formalized process procedures, training and deployment of the process on a division-wide basis.

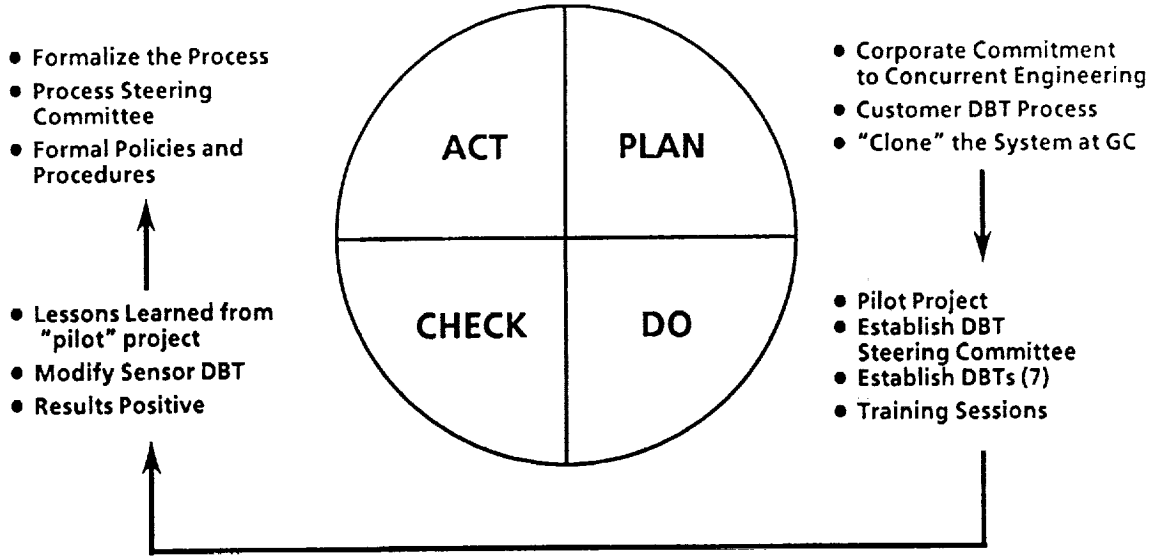


Figure 6 Evolution of the Design Build Team Process

As we began to develop the formal design-build procedures we identified four (4) key components of the process that required specific proceduralization at the division (see Figure 7). First was an overriding policy statement (P&P 6.7) that clearly states and acknowledges Management's Commitment to a team oriented, disciplined approach to new product development. The myth that engineering is an art that cannot be defined by an underlying cooperative process cannot be allowed to persist. Second, the definition, composition, roles and responsibilities of Design-Build Teams (P&P 6.8) are defined, as well as consensus and appeal procedures to prevent deadlock. Third, Management Roles and Responsibilities in the review process are defined and checklists provided (P&P 6.9). The key here is to make these periodic reviews a non-threatening and value-added process. They serve to keep a direct management involvement in the product development process and provide opportunity for recognition of the project team for goals successfully achieved. Finally, the methods for conducting detailed design reviews incorporating lessons learned checklists, and action closure logs were defined (P&P 6.10). These technical reviews are to ensure that product performance and product safety requirements are met, as well as functional department initiatives for design practices, standardization and reuse.

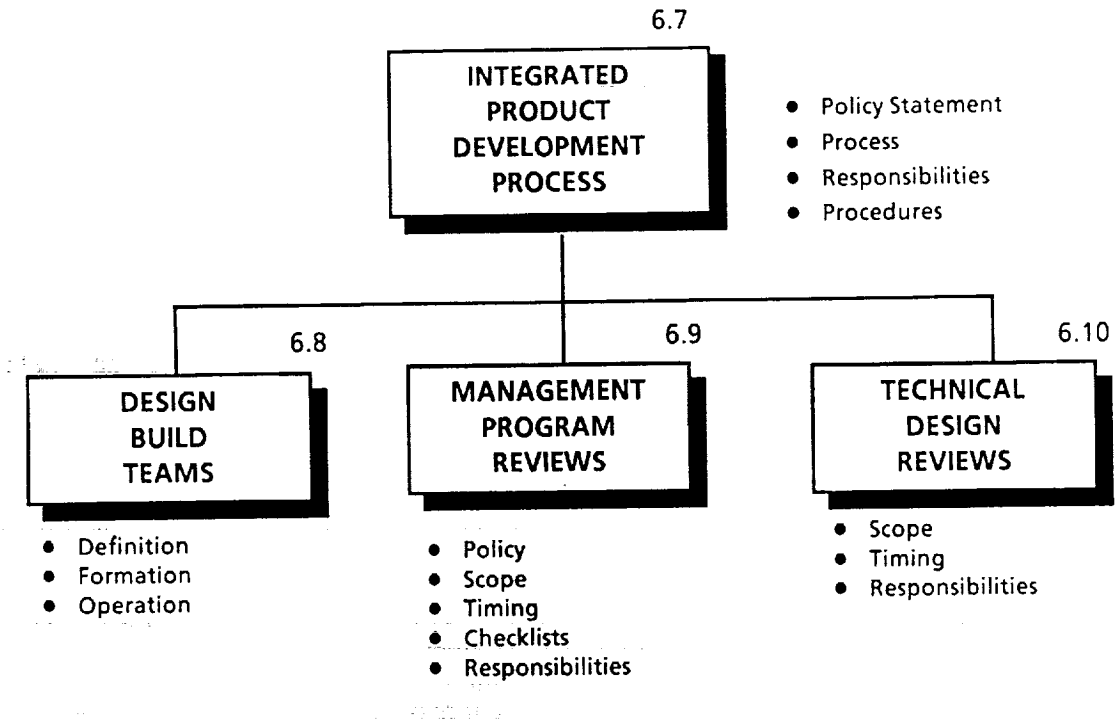


Figure 7 Integrated Product Development Process

LESSONS LEARNED

During the pilot project and evolution of the Design-Build Teams, an integrated Product Development Process Committee was formed and chaired by the Vice President, Engineering. Members included the pilot project Engineering Team Leader, the Program Manager, the Manufacturing Manager of the New Product Module, a Quality Assurance Engineer, and the Director of Design Engineering. This committee met approximately bi-weekly for a period of six (6) months to track the pilot project, interview DBT members, develop policies, procedures, training materials and process deployment plans. The Division President and Executive Staff were briefed periodically on project status, participated in two Management Program Reviews, and key members reviewed and commented upon the policies and procedures as they were developed. The Management Process Committee conducted two half day training sessions on the Design-Build Team process for division mid-management and functional supervisors who would become involved in the DBT approach to new product development.

Prior to division wide deployment of the process, a summary of the Key DBT Lessons Learned at that point was as follows:

- Set Stretch Goals
- Supervisor Support Required
- Follow Up Training Required
- Process Needs formalizing
- Disciplined Adherence To Process Essential
- Strive for Real Consensus
- Rigorous, Critical Reviews Necessary
- Physical Co-Location Helps Mental Co-Location

First is a clear project goal, which represents enough stretch to displace the "Lets work a little harder" paradigm and an openness for new approaches to develop. Support from first line supervisors and middle managers from the functional departments is essential. They feel the most threatened by this process and communication, training and re-enforcement of their importance to the process is critical. The shift of role from "supervisor" to "coach", and the delegation of decision-making to team representatives are difficult challenges which we have to address.

A one-time training effort is not sufficient. The new process requires continuous reinforcement in its early stages. As DBT members change due to employee turnover, reassignments or as the project moves into later stages, this initial training will help refamiliarization. More focused training to address specific team needs must also be provided.

The process must be formalized, documented and deployed across all affected departments. It was useful to solicit input and comments from key department managers during development of the top level command media to assure wide-spread "Buy-In"to the process.

The need for better tools and a higher degree of automation has been identified as a critical success factor. Being planned is implementation of formal Design For Manufacturability and Assembly (DFMA), centralized databases for lessons learned and functional checklists, and Quality Function Deployment (QFD).

Once established, a disciplined adherence to the process must be enforced. Automated tools, routine use of the review process with Lesson-Learned checklists and closed-loop action tracking are important to success. We are maintaining an active process overview committee, and process changes with upgrades are planned so that improvements may be incorporated and a method of removing areas of discontent is available. Real, not apparent consensus is the foundation of the team approach to the design process. The initial fear of "Design by Committee" must be displaced early. A norm of open, honest dialogue with fact based decision making must be established. Rigor and constructive criticism from peers during team meetings, and from management during reviews, is essential to ensure that progress is reported accurately, and that risk assessment and risk avoidance plans are realistic. This rigor reinforces the need for accurate data in order to "act on fact". Out of the IPD process came improved metrics and a better understanding of the numbers, causes and impacts of design changes on the manufacturing process and the installed base.

Role playing and consensus building exercises during initial training were found to be helpful and also the more successful teams were comfortable with rigorous open and critical technical reviews. Shifting the focus to customer satisfaction tends to disarm the inherent

defense mechanisms and sets up a common goal for all team members. This focus also helps to combat the "Abilene Paradox" - in which all members of a team reach agreement to a particular course of action at a team meeting, but individuals in that team would disagree with the course of action when questioned separately.

Finally, team members who were located together benefited from the improved communications. Although it is not possible for all resources to be dedicated and co-located, team meetings and program/technical reviews served to reinforce the "mental" co-location.

WHAT'S NEXT

Teams have been formed to automate and standardize the lessons learned data base and a review discrepancy tracking system. Members of the original pilot project DBT's have been retrained, the next several projects to use the process are scheduled for training and by the end of the year all new product development projects will use the process. Additional training modules to provide improved team dynamics, leadership skills, and support tool introductions are planned (including DFMA, QFD, Design of Experiments).

Better process metrics are being developed. Better tools to help the teams make more informed cost decisions during the design cycle and another PDCA cycle to implement automated DFMA analysis tools has been initiated. The simple four-phase PDCA cycle is now being expanded to follow the Allied-Signal 9 step PI/PS model.

A simplified process guidebook to serve as a reference document in support of the policies and procedures is scheduled to be released in the next few months. The IPD Steering Committee will focus on best practices and continuously feed improvements to the teams. Finally a preplanned process review and command media upgrade will be conducted.

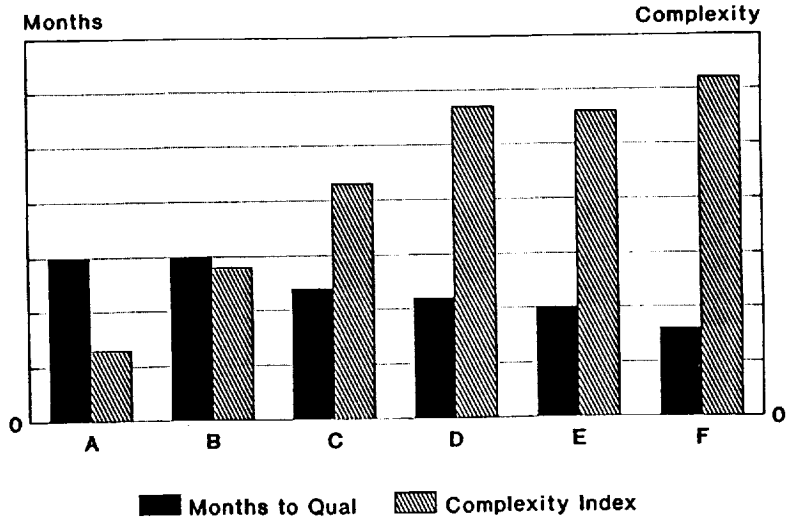


Figure 8 Cycle Time vs Complexity

SUMMARY

At Garrett Canada an integrated new product development process has been implemented which captures the power inherent in multi-functional Design-Build Teams. Customer and supplier representatives have also participated and relationships have been strengthened. Results to date are showing specific reductions in product and development costs in excess of 25%; and new product development cycle times are being reduced even though the product complexity is increasing (see Figure 8). Additionally, design and test approaches have evolved from these teams which have offered additional savings for non-related projects. During the development of this new process a Deming/Shewart PDCA cycle was followed which is now serving as a model as we address other division critical operating processes.

Getting the product designed "right the first time" is only half of the battle for improved cycle times and business performance. We also had to address the procurement and manufacturing cycles and the provision of high quality products so that we could satisfy our customers' needs and expectations.

CYCLE TIME REDUCTION THROUGH TOTAL QUALITY TEAMS

BACKGROUND

Traditional order-to-delivery cycle times in the aerospace electronics industry are measured in months, resulting from long material procurement leadtimes and long manufacturing cycles. These long cycle times result in increased investment in inventories, and reduced flexibility and responsiveness to change in product or schedule.

Improving material supply and manufacturing cycle times will enhance competitive advantage through reduced inventories, lower quality defects, increased responsiveness to changes, lower operation costs, and better customer focus (see Figure 9).

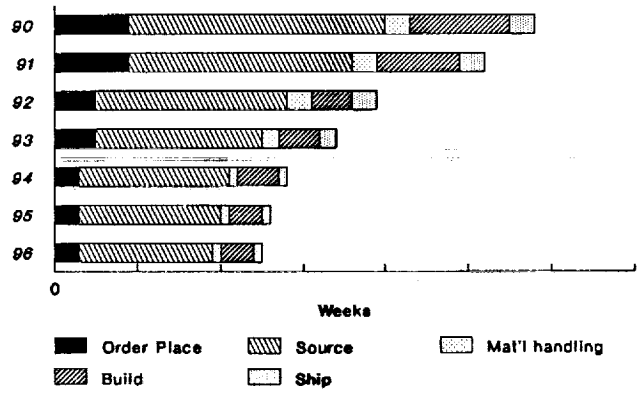


Figure 9 Operations Cycle Time Reduction

Specialist support functions have traditionally driven improvements in operational efficiency; but such efforts have failed to achieve the full potential of the synergy which results from involving all employees in the improvement initiatives.

Garrett Canada has developed and implemented a number of cross-functional Total Quality teams deployed to improve cycle times through the order-to-delivery process.

ORGANIZATION

The company organization is in the process of being redefined where necessary to focus on Customer Satisfaction through reduced cycle times. Traditional hierarchical organizations are characterized by slowness, bureaucracy, functional silos, and individualism. Changing the structure of the company is fundamental to achieving a fast, responsive organization. The company reorganization included delayering supervisory and management levels (see Figure 10), consolidating near-duplicate functions, and eliminating non-value added work and this reorganization process is continuing.

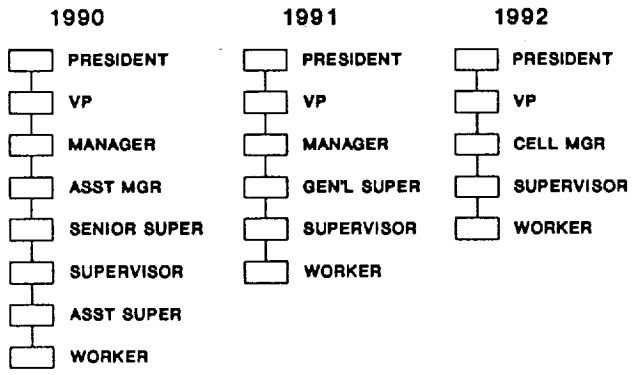


Figure 10 Organizational Restructuring For Speed

Simplifying the organization is resulting in lower costs, shortened cycle times, improved levels of quality, improved communication, better customer service, and last but not least, improved employee morale.

CREATING THE TEAMS

a) The Operations Managers (8) became a steering group to coordinate the overall TQ team efforts, with the need to avoid duplication or overlap of team efforts, and the need for the teams to achieve tangible results.

b) Successful teams require a management mentor to act as a coach who provides encouragement, and runs interference when the team reaches a roadblock beyond their control.

c) Another key element of a successful team is a clear understanding of commonly defined stretch goals and expectations. This is achieved through assigning a draft problem statement to the team, followed by a review of the team's final definition of the problem which they are to solve.

d) Teams are formed from "natural work groups" - those individuals who would naturally be formed to solve a problem or improve a process - they may consist of members of only one department, or may comprise of representatives from several departments or several company functions. The team membership rarely changes until the team's problems is resolved (ie. membership does not rotate).

e) The team leader is identified by the Operations Management Steering Group, as an individual who has a significant stakeholding in resolving the problem, who has the commitment and drive to see the problem resolved, and who has the necessary people-skills to lead a team. The team leader works with his Management mentor to identify the team members needed to solve the problem.

f) Once formed, a team is provided with basic Total Quality training on objective/goal setting, problem solving and team interaction. This team interaction includes establishing team member responsibilities and defining a code of conduct and team norms. During this training, emphasis is placed on the need to solve the root causes of the problem and not simply to fix the symptoms, and to demonstrate a basis for action. This is achieved through the use of the 9-step PI/PS model, and the use of ambitious but achievable schedules for completion of the team task.

g) Finally it is made clear to the team that they have the responsibility and authority to resolve the problem - they are empowered by Management. Support from the Management mentor and the whole company Management team reinforces this empowerment on a regular basis, and builds commitment of individual team members.

In addition to the Design-Build Product Development Teams already discussed, we currently have thirty (30) TQ Teams chartered to improve processes throughout the operations activities. These teams include:

Linear Shipments	A team with participation from Operations, Engineering, Contracts, Quality, Program Management and Accounting meet daily to resolve critical issues impacting shipments.
Quality Ownership	A team was formed within manufacturing to dramatically alter employee attitudes towards quality and drive significant improvements in both process and products.
Concurrent Design	Teams were formed to fundamentally change the working relationship between Design Engineering, Operations, Quality Assurance, Suppliers and Customer Support.
Dimensional Issues	Teams were formed from Engineering, Operations, Quality and Suppliers to aggressively eliminate delays caused by dimensional issues and product design resulting in radical shift in the design concept.

Solder Defects	Team formed to dramatically drive down rejects off the wave soldering machine (see Figure 11).
Past Due	Team formed to virtually eliminate controllable past due shipments (see Figure 12).
Growth	A program-specific team formed to slash delivery times and win the order in a new business area (see Figure 13).
Factory Redesign	A natural work team formed to design their own dedicated work cell for a specific customer product line.
Critical Items	A team of Management representatives from each function was formed to identify critical items affecting short-term operating performance. Meeting on a daily basis, this team is able to cut through bureaucracy and quickly initiate change.

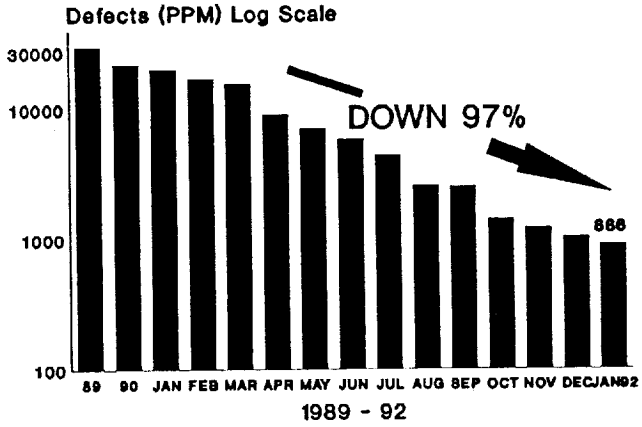


Figure 11 Solder Defect Reduction

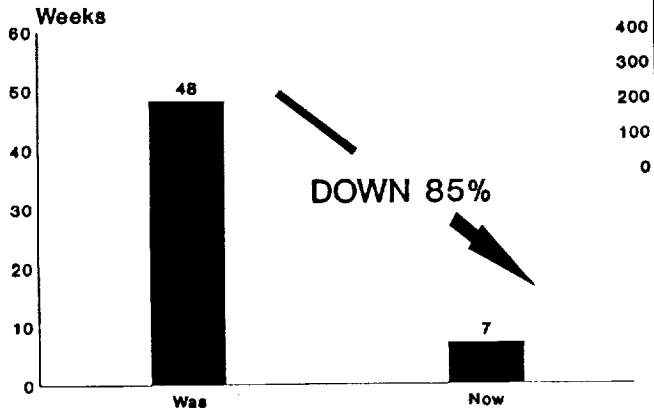


Figure 13 Manufacturing Delivery Time

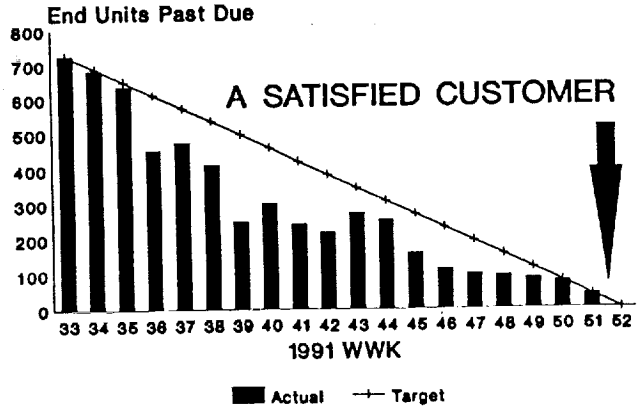


Figure 12 Units Past Due

RESULTS

We have moved the "yardsticks" forward. Our critical success factors are simple. Set stable priorities and develop our Human resources. Significant accomplishment through the use of cross functional teamwork have payed substantial dividends. We are reaping the benefits of a "greenfield" approach to redesigning our factory without the short term cost and time penalties associated with such a strategy. Some of our key accomplishments are listed below:

Increased factory sales per operations employee by 46%

Delayered organization by 2 levels

Reduced wave soldering defect levels from 20,000 PPM to less than 1000 PPM

Reduced Past Due
Total past due slashed from 42 days to 13 days in 5 months
One major customer's past due reduced to Zero

Reduced one program lead time from 10 Months to 38 days (potential business opportunity $16M)

Reduced Controller lead times by 25%

Increased Burn-in Yield from 80% to over 90% while Reducing test labour by 80% through automated test

Reduced defects by 20% through Quality Ownership program (at the same time reducing Inspection census by 16)

Reduced one program shipset cost by 26%

Increased Outgoing Shipments linearity from 52% to 86%

Saved 9% on $20M through supplier partnering and purchase economies

Over 20% of our vendors are now Certified Vendors

Increased the amount of materials received from Certified Vendors/Source Inspected to over 30%

Eliminated all work in process stops due to dimensional issues

LESSONS LEARNED

a) Utilize ground won by others

In the area of external orientation, key employees visited other ASAC divisions to counter the "not invented here" culture. We have benchmarked our performance against other Allied-Signal Divisions including AiResearch Los Angeles Division - Software processes; Allied-Signal Engine Controls Division - Quality Function Deployment process; AiResearch Tucson Division - Cost/schedule control.

In Operations, we participated in the Canadian multi-industry Manufacturing Visits Program involving over 50 companies to learn how others are dealing with competitiveness challenges.

On the international front, 3 key Directors/VP's toured the U.S, Europe and Japan to view how world class operations are meeting the challenges of the nineties.

We will continue to benchmark our performance and learn from the best - both inside Allied-Signal and outside the corporation. As a result of our efforts to date, the number of "agents of change" is more than adequate to sustain the momentum for cultural change in all areas of Garrett Canada.

b) Team formation/effectiveness

The normal team cycle of "form - storm - norm - perform" can be improved through the use of TQ Leadership Training. The "form","storm" and "norm" effort can be drastically reduced through the use of effective training and a common approach to team norms and PI/PS models; everyone speaks a common language and has a common understanding of the tools.

c) Symptoms vs root cause

In the past, we have spent a lot of effort fixing symptoms - only to have the problem recur later - or to create a new problem. The PI/PS model used by Allied-Signal applies considerable effort to defining the problem, and to identifying the team players necessary to resolve the problem. With management support and effort, a clear definition of the problem can be established and the team is then better able to resolve the root causes.

d)"What you measure is what you get!", and "What gets measured gets improved!"

Meaningful metrics are fundamental to the improvement process. Metrics are the facts on which we act. They establish the basis for problem identification and for evaluation of alternative solutions. They provide the feedback to measure the effectiveness of process changes. They provide the foundation for performance evaluation of departments and individuals. Most importantly, they provide the touchstone of our customers needs and expectations. Garrett Canada's system of metrics is continually reviewed to ensure that they reflect the changing needs and expectations of our internal and external customers.

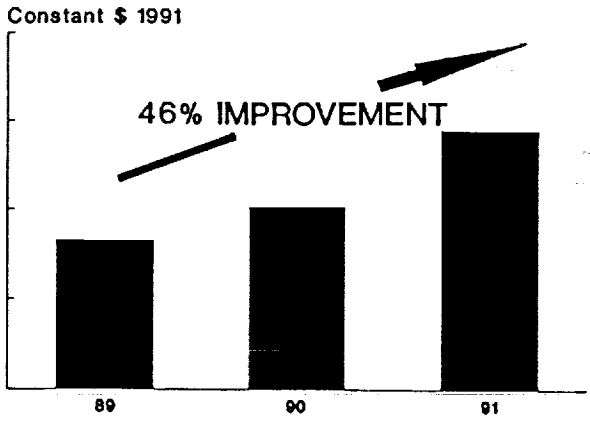


Figure 15 Factory Sales/Ops Employee

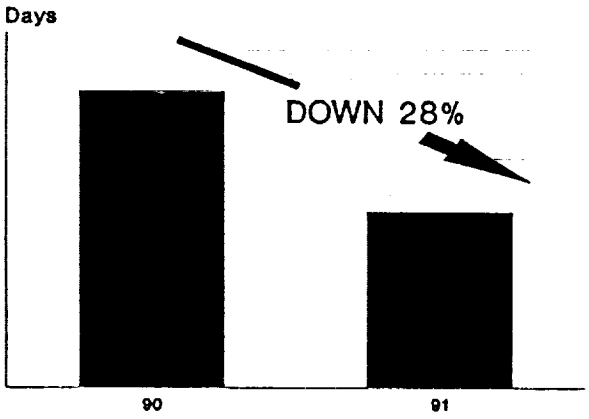


Figure 16 Manufacturing Inventories

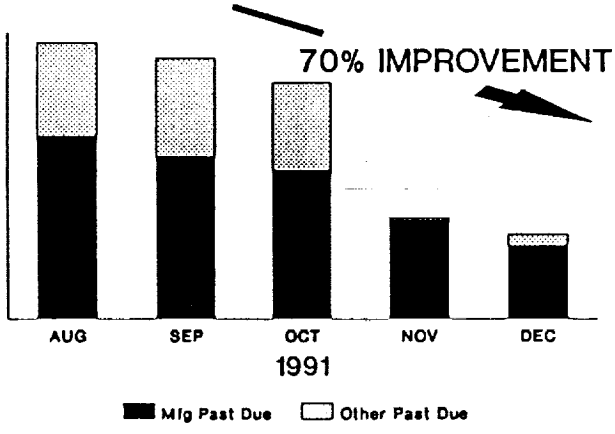


Figure 17 Total Past Due

THE FUTURE

As Total Quality becomes embedded in our behaviours, there will be more TQ Teams chartered to improve our processes. This will require formal policies and procedures which establish guidelines for obtaining a Team Charter, and for Problem Screening and Prioritization.

Recognition and reward systems such as "gainsharing" are being evaluated to reinforce effective teamwork.

As we look towards self-directed work teams, changes in middle management's role will need review, as their role evolves into one of a coach rather than a traditional manager.

CONCLUSION

The improvements in cycle times achieved through our Cross-Functional Teams and our Integrated Product Development Process translate directly into improved business performance and product and service quality. Factory Sales per Operations Employee is up 46%(see Figure 15), Manufacturing Inventories are down 28% (see Figure 16), Past Due is down 70% (see Figure 17), typical cycle times are down 25%, and quality levels are higher.

Our quality is best measured through the eyes of the customer and by the customer's confidence in us and our people. The best indicators to attest to this high confidence is the authority to accept product on their behalf:

> Department of Transport Canada has authorized nine Garrett inspectors to sign Certificates of Airworthiness.
>
> Boeing has authorized three source inspectors.
>
> General Dynamics Ft. Worth and Land Systems have each authorized two source inspectors.
>
> Garrett Canada won the prestigious Northrop Gold Key Award. This is the first time this award has been granted outside the United States.

Also worthy of mention, the Canadian Government has recognized Garrett Canada's commitment to customer satisfaction and improvement by awarding Garrett Canada with a Certificate of Merit for the Canadian Awards for Business Excellence (a Canadian award system equivalent to the Malcolm Baldridge Award).

Cross-functional teams and the Integrated Product Development Process are yielding significant improvements in business results for Garrett Canada, along with improved customer satisfaction and enhanced employee morale.

We will continue to tap the enormous potential of our employees as we travel on our never ending journey of continuous improvement.

oooOOOooo

omit

D3 Assessing TQM Results: What to Expect

This panel looks at companies that have successfully implemented TQM tools and techniques.

Jerry D. Bullard, SCORE Team Leader, Federal Systems Division, TRW Space and Technology Group, **"Spacecraft COst REduction Team (SCORE)--TQM/CI on a Massive Scale."**

John L. Connell, Chief Software Methodologist, Sterling Software, **"Object-Oriented Productivity Metrics."**

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Spacecraft COst REduction Team (SCORE) — TQM/CI on a Massive Scale

Jerry D. Bullard, SCORE Team Leader,
Federal Systems Division, TRW Space & Technology Group

A. Introduction and Summary

The business of building satellites and space systems has matured. Few missions require, or can afford, excellent performance at any price. The new paradigm is doing more with less, providing quality systems at lower cost — in other words, doing our job "FasterBetterCheaper."

The TRW Spacecraft COst REduction (SCORE) initiative was launched in 1990 by Daniel S. Goldin, then general manager of TRW's Space & Technology Group. The SCORE mission is to apply continuous improvement (CI) techniques to effect major reductions in the cost (our primary goal) and span time (as a corollary) required for the production of spacecraft.

SCORE is a multiyear initiative that is having a profound effect on both procedural and cultural aspects of how we do business. And the objectives of this initiative are being realized.

The focus of this paper is not on the results of SCORE per se, but rather on the things we have learned about how to do continuous improvement on a massive scale, with multilevel (hierarchical) CI teams. The following sections summarize the chronology of the SCORE initiative, from team formation to development of the year-end report for 1991. Lessons learned, the core of this presentation, are discussed — with particular focus on the unique aspects of SCORE.

The SCORE initiative is continuing and, as a part of our evolving culture, will never end. It has resulted in profound insights into the way we do work and (the topic at hand) how to do CI for large and complex multidisciplinary development activities.

B. SCORE TQM/CI Process Chronology

B.1. Team Selection and Formation

The SCORE team was a natural progression from the CI efforts started in 1989 by a number of "grass roots" teams in our operating divisions. Teams were formed in small work areas to look at local processes and determine how they could be improved. These teams were largely unfunded, meeting during lunch hour or after work. One of the recurrent frustrations in these early efforts was that when a team got to the boundary of its functional specialty, the participants had difficulty determining how their processes interacted with those of other areas. SCORE was conceived to bridge this gap.

The concept of SCORE is to employ a senior cross-functional team to look into all aspects of the process of designing, fabricating, assembling, and testing a generic spacecraft bus. The scope of the effort encompasses a bus project from authority to proceed (ATP) through launch of the first

satellite. Comprised of representatives from each of the organizations of Space & Technology Group involved in the processes under study, the team was formed in December 1990. Members were appointed by skill center managers from the Applied Technology Division (propulsion design and hardware), Engineering & Test Division (bus hardware design and spacecraft assembly/test), Electronic Systems Group Manufacturing Division, and the Space & Technology Group subcontracts and product assurance functions. Each member reported directly to the nominating manager and, in SCORE matters, spoke with his voice. All disciplines involved in the production of a spacecraft were represented:

Program management
Business and administration
Mechanical engineering
Control, sensors, and mechanisms
Power systems and integration
Spacecraft electronic systems
Propulsion
Manufacturing (including parts, materials, and processes)
Propulsion
Assembly, test, and launch
Mechanical ground systems and environmental test
Systems engineering
Subcontracts
Product integrity (quality assurance, reliability, producibility, maintainability, etc.)

To assist in helping this large group interact effectively and function as a team instead of a committee, we included a full-time facilitator. The facilitator's tasks were to observe rather than participate in the team's activities, provide training in team techniques as needed, and make sure that we followed the rules we set.

It was evident from the beginning that the team needed to establish norms of behavior, rules, and an operating philosophy. We jointly developed a set of rules, agreed to follow them, and posted the list prominently in the meeting room. As we progressed through 1991, we found that adhering to these rules helped significantly in achieving genuine teamwork. For example, the rules and operating philosophy require that team decisions be reached by consensus, not by simple majority. Decision by consensus promotes ownership by each team member. The rules further require that decisions be based upon data; this guideline helps members focus on process, not personal prejudice or emotion.

B.2. Team Training

Each of the team members had individually participated in our CPI® Boot Camp, an orientation to the principles of process improvement, but there was no group training prior to team formation. To get us started, we were trained in the techniques of defining the "as-is," "could-be," and "should-be" process flows, then determining barriers to implementation. As the team progressed, we received "just-in-time" training specific to the task at hand. While generally following a classic process improvement flow, we did deviate when it made sense. For instance, some teams approach the "as-is" step by constructing a flow chart of every process involved to the lowest level of detail before further analysis. Because were trying to determine which processes had the greatest impact on the overall spacecraft process, we decided to define each process only in enough detail to be able to understand its impact on the whole.

B.3. Methodology Selected

The SCORE team employed a variety of TQM/CI tools and techniques in 1991, during a process that was largely one of discovery. We were determined to be driven by data instead of opinions. This commitment, coupled with the complex nature of modern spacecraft, led us to a hierarchical three-level teaming approach — and the use of a variety of tools, some quite successful and some less so.

Process Flows and Maps

Our first effort to define the total problem was based on detailed process flows. The SCORE team attempted to construct a comprehensive, detailed, cross-functional spacecraft process flow on a large wall (approximately 8 by 35 ft). After consuming several hours over a couple of meetings, it was apparent that this approach was futile. We concluded that another methodology was required.

Definition of Levels

Spacecraft development is by nature a multilevel process. We decided to emulate this hierarchy. Level 1 was defined as the total program, divided into time spans associated with major review milestones (e.g., ATP to PDR, PDR to CDR, etc.). The SCORE team became the Level 1 team. Level 2 was defined in accordance with major spacecraft development processes: requirements to design; mechanical design through manufacturing; electrical design through manufacturing; propulsion through manufacturing; assembly, integration, and test through on-orbit checkout; subcontracts; and program management. Level 3 was defined as the unit level.

Seven key teams were formed (Figure 1) to address Level 2 processes. Each of these teams validated the Level 1 flow developed by SCORE, and developed Level 2 process flows, defining Level 3 subteams where they were needed (primarily in the design-through-manufacturing teams). Ultimately, the seven key teams formed 38 unit-level teams involving more than 250 employees. All teams were cross-functional, with representatives from systems engineering, subsystem

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engineering, engineering specialties, design, integration and test, manufacturing, and subcontracts — as deemed appropriate by the Level 1 team.

Data-Driven Approach

The Level 2 teams defined process flows for the activities they addressed, with support from the related subteams. These flow diagrams (process definitions) were used to focus the collection of "as-is" data from selected existing and completed programs. The primary data collected and analyzed were cost (or man-hours of labor) and span time. Often it was necessary to modify the flows to better match the structure of data available from the programs. The quality (detail, documentation, definition, completeness) of data from the programs was a major hindrance, particularly when dealing with the "intellectual" phases of the programs (such as system engineering).

Selecting High-Leverage Processes

The need to focus on those processes having the highest leverage was apparent from the beginning. Our main tool in defining leverage was the Pareto diagram, with "as-is" cost the parameter addressed. This approach was applied with good success for those processes (design, integration and test, manufacturing) where the program data was relatively high in quality.

Pareto diagrams were less successful for the requirements-to-design (RTD) processes. Discussions in Level 1 team meetings, supplemented by more formal techniques (Ishikawa diagrams coupled with multi-voting) made it apparent that many of the downstream (e.g., design) problems were related to the quality of RTD work — and that simply reducing the cost of RTD work could well lead to a higher total program cost. This investigation led to the definition of a major 1992 initiative focusing on the Integrated Development Process (IDP).

Developing "Could-Be" and "Should-Be" Processes

"Could-be" processes were developed first, and were defined as the best processes possible without constraints related to organization, facilities, etc.; in effect, the could-be processes represent a long-term goal. The "should-be" processes were less ambitious and realizable in the near-term environment. In some cases, the could-be and should-be processes were very close in terms of the key cost metric; in a few they were not. The should-be processes were used to define attainable cost reductions, in terms of continuous improvement (CI) factors.

B.4. Summary of Results

We collected data on 553 "as-is" processes and combined them into 383 processes for analysis. Through a combination of Pareto analysis and brainstorming, we identified high-leverage processes and performed cause-effect analyses upon them. We defined "should-be's" for 107 of the 383 processes and developed 112 specific recommendations for improvement.

C. SCORE Lessons Learned

C.1. Team Composition and Commitment

Team members were nominated by their skill center managers. The main selection criteria were a good knowledge of the work area and a desire to contribute to a process improvement effort. In general, those nominated volunteered for the assignment. Each team member was asked to commit a minimum of 16 hours a week to the SCORE effort and to agree to attend all of the SCORE meetings.

C.2. Meeting Frequency and Timing

We started with two 8-hour meetings per week. We quickly found that no more than 4 to 5 hours of that time were productive, and there was no time left for members to follow up on action items outside the meeting. After experimenting a bit, we settled on two 4-hour meetings a week. That seemed to be a good compromise and was our schedule for most of the year. As the Level 2 and 3 team activities expanded, the core team meetings were cut to 2 hours twice a week, then to one 2-hour weekly meeting. When special issues arose, the meeting time was expanded to accommodate the need.

C.3. Team Leadership and Culture

Leadership

Leading a team such as SCORE is different from managing a project. The members are expected to interact differently in a team setting. In a project setting there is a clear hierarchy understood by all; in a team setting, members are expected to contribute equally and to have their ideas considered equally without regard for rank, status, or position.

Ideally, the leader acts as a coach. He must make sure that the group operates as a team rather than as a committee so that each member has a personal commitment to the result. For each problem encountered or issue addressed, the team must come up with its own answer. If the leader defines too detailed a plan for resolution, the members will fill in the blanks but not own the result. The leader also must be very careful to keep personal prejudices and preconceived solutions out of the process. To own the result, the team *must* develop it themselves.

To get the maximum benefit from a process improvement team, one must set a dramatic goal as a challenge to creativity. Small (10 to 20 percent) improvements can usually be accomplished easily within the existing process framework. To achieve true breakthrough improvements (40 to 70 percent), the goal must be seemingly unattainable. The leader must develop a personal vision of the goal and continually assert that it can be accomplished, then lead/nudge the team in the direction of the goal.

Requiring that decisions on team activities be made by consensus seems at first to be abominably inefficient. Nonetheless, the object is to have all of the team members fully involved in decisions so that they can support the result with one voice. Therefore, discussions must be continued until everyone can agree or not strongly disagree with the result.

It is imperative to have a clearly defined mission statement to focus upon, otherwise there is a tendency to wander. The statement need not be elaborate but must be sufficiently clear that you can tell when you have accomplished it. The SCORE mission statement, for example, is short and to the point:

> The study is directed at a generic spacecraft flow.
>
> Define the "as-is" process flow (including cycle times) from authorization to proceed through on-orbit customer selloff.
>
> Determine high-leverage processes to investigate further. Develop a "should-be" overall process flow (including cycle times) applicable to a broad range of spacecrafts projects to: reduce cost and cycle time dramatically while maintaining or improving quality.

It proved to be equally important to develop a set of meeting rules and require strict adherence to them. We had a practice from the beginning of developing a written agenda for the next meeting as one of the last items of business in every meeting. That was useful, but what we found was that we tended to belabor the earlier items and never get through the entire agenda. When we began to set a time limit for each agenda item, the situation improved somewhat. Finally, when we rigidly enforced the time limits even to the point of interrupting conversations in mid-word, we achieved our highest meeting effectiveness scores. It seems that the stress caused by dictatorially ending discussion was more than offset by the sense of accomplishment achieved by addressing all of the agenda items.

Meeting effectiveness was measured for each meeting, then plotted and displayed in the meeting room. The measurement technique is simple and can be applied to any sort of meeting. At the end of the meeting, using a scale from 1 to 10, each member rates the Efficiency (how well the conduct of the meeting followed the rules) and the Importance (how important the meeting content is to him). All the E and I scores are averaged and multiplied together to produce an Effectiveness number. The Effectiveness can be dollarized to provide a measure of the "cost of lost opportunity" by subtracting the Effectiveness score from 1, then multiplying by the number of attendees, the length of the meeting, and an average cost per unit time for the attendees. It was interesting to note that the highest scores were achieved when the rules were most rigidly observed. It is therefore up to the leader to enforce the rules developed and adopted by the team. Demand excellence but realize that it can take many forms, and realize that schedule pressure to produce "something" offends the purist but results in helping to end "analysis paralysis."

Cultural Aspects

We discovered early on that we are event (schedule) oriented, not process oriented. Furthermore, the detailed examples usually given of a CI process are oriented toward short processes that repeat frequently, such as forms handling and high-rate manufacturing. It was difficult to relate these examples to the processes of requirements definition and detailed design. We ultimately settled upon a format for depicting our requirements and design processes in terms of a list of inputs, functions performed upon them, and a list of outputs. We are still inventing a way of viewing a lengthy spacecraft program in a process context.

The form, format, and conduct of the meeting are subtly critical to the outcome. There is a tendency for the meeting to become a project review where the leader, not the rest of the team, is presented with the pieces and expected to do the synthesis and make the final decision. We found this to be true after we launched the seven key teams mentioned above. Since all of the core team members could not attend every key team meeting, we added a "Key Team Leader Report" to the standing agenda. Each team leader was asked to share the progress of his team with the core team and was allocated a maximum of 5 minutes to do so. Within eight meetings, this agenda item became a de facto project review — with each team leader addressing the SCORE team leader, not the team, and feeling compelled to fill his time allocation whether or not he had anything to report. This behavior persisted even after I called attention to it numerous times. We solved the problem by eliminating the reporting agenda item and substituting one called "Issues." If a team leader had something to report to the team, he was required to write it on a white board before the meeting started. When we got to the issues item, we would vote on whether to address a given issue and set a time limit for its discussion.

While generating a process flow or map, there is a strong tendency to focus on fixing individual problems immediately and to lose focus on the bigger picture. Giving in to this tendency leads to a "tiger team" approach and the effort falters. Our solution was to set aside a wall area in the meeting room and label it the "Should-Be Parking Lot." As individual problems or non-value-added processes were found, they were listed on the parking lot to be addressed later when we progressed to the "should-be" development phase.

In analyzing the "as-is" and developing improvements, there was a general perception that most of the barriers to performance are external to one's own area. Forcing the teams to be cross-functional helped to mitigate that perception. It also helped overcome the fact that we have organized ourselves into such narrowly defined specialities that it's hard for an individual to identify how his or her actions affect the final product.

Having a few "nay-sayers" in the group improves the process by challenging the rest of the team. Nay-saying is often a way of talking out and defining a problem more clearly — or at least defining the barriers to solution.

A feeling of empowerment in the team members is developed by action and example, not by decree. It comes slowly and is the result of experiencing favorable response to success and tolerance of failure.

C.4. Implications of Multiple Levels (Key Teams and Subteams)

SCORE was unique in that it became a hierarchy of teams. The original concept was of a single team, but as we developed the Level 1 flow, it became apparent that more teams would be needed. With nearly 400 processes identified in the Level 1 flow, we formed seven key teams to study them in detail. The key team leaders were selected from the SCORE core team. Each of the teams was required to have cross-functional representation appropriate to its area of investigation. The task of the key teams was to validate the Level 1 flow developed by SCORE and define in more

detail the processes defined at Level 1. As the key teams formed and developed Level 2 process flows, they also found they had to create additional teams.

In all, 38 unit or Level 3 teams were formed. As with the key teams, each unit team was required to have cross-functional representation. The unit-level teams studied the lowest level of detail in a process, usually involving one work area, and provided a natural conduit for grass roots team results to be considered in the context of the entire enterprise.

The role of the core team changed as the additional teams were formed. We generated the Level 1 flow as a team then changed into essentially a steering committee for the lower level teams, then became a team again to synthesize the results of the other teams.

C.5. Tools and Techniques

As mentioned above, we tried a variety of tools and techniques with varying degrees of success. We set out to construct the Level 1 flow as a classic flow chart and failed twice. Then we tried to construct an N^2 chart and failed. On the fourth attempt, we divided the task vertically into time slices defined by major program events, and horizontally by discipline or where work is performed. This time we succeeded and defined nearly 400 processes for further study. Figure 2 shows an outline of the Level 1 flow. Within the horizontal lines, each team member constructed a flow of his work area as that discipline viewed it. Interfaces between disciplines were represented by connecting the source and destination points. Along the timeline, some events were put in quotation marks (e.g., "PDR") to signify our awareness that when the program conducts a formal Preliminary Design Review, not all disciplines have reached the same level of design maturity. We used "PDR" to indicate a state of completion consistent with the classic definition of PDR.

The Level 2 teams had difficulty with detailed flow charting as well. They developed a technique of defining a process in terms of inputs, operations performed on the inputs, and outputs. This method provided sufficient insight into the macro process to identify areas with the most leverage. The Electrical Design through Manufacturing key team discovered a significant benefit from this approach. When they began, they formed unit teams to study processes related to 16 different products. They were convinced that the products were unique and therefore the processes must be unique as well. When they reviewed the flows produced by the 16 unit teams, they discovered that the processes used to develop the 16 different products could be described by only seven different process flows!

C.6. Networking with Other CI Activities

We made a conscious effort to learn from the experiences of other CI teams. Several of the SCORE team were members of other teams in TRW Space & Technology Group and Electronic Systems Group and were able to bring "lessons learned" to our meetings. In spite of the good intentions of all concerned, however, we found that usually we didn't really understand until we had made the same mistake ourselves.

C.7. Follow-up: Acting on the Findings in a Continuous Improvement Environment

For 1992, SCORE has begun to implement the suggestions derived from the 1991 work. We are sponsoring 16 implementation initiatives that touch most of the work areas. The largest of these efforts is the Integrated Developed Process (IDP) team, whose task is to define an IDP in our work environment that will result in a high level of design maturity and a physical configuration freeze at PDR.

Our future plan is to implement new processes as opportunities occur and continue cause-effect analysis of additional processes. We will analyze the effect of the new or changed processes on the overall Level 1 flow and iterate until the goal is met.

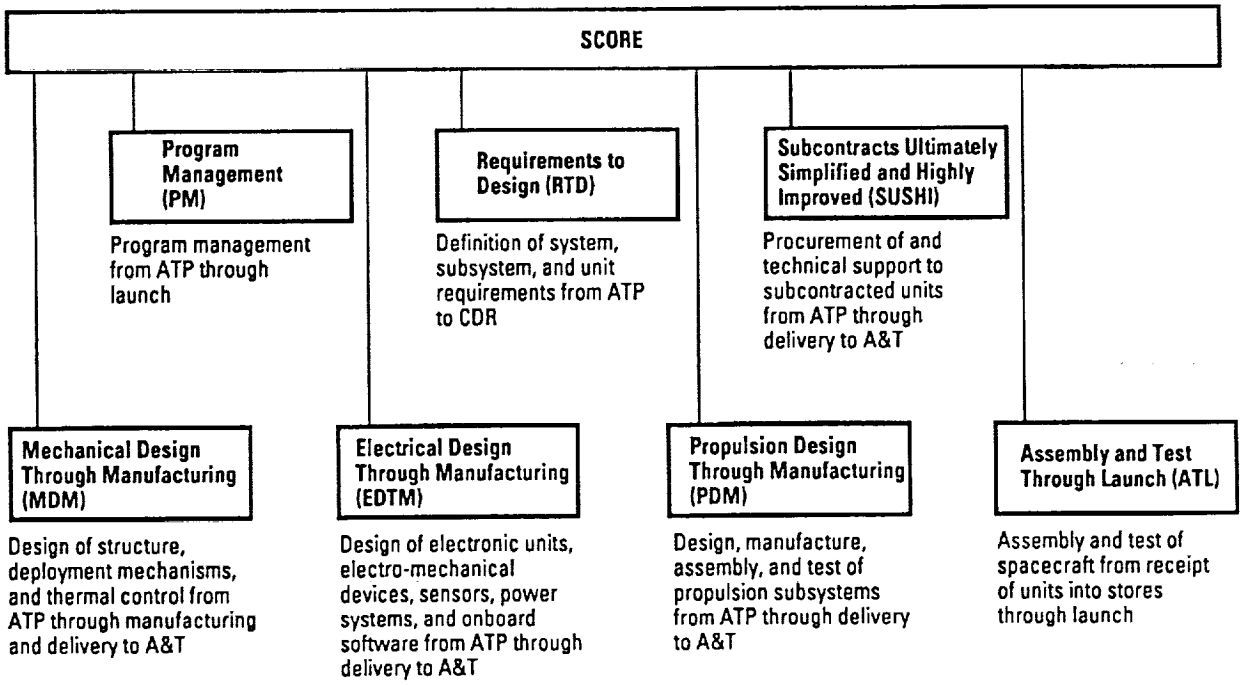


Figure 1. Seven Key Teams Addressed Level 2 Processes

Work Area \ Program Phase	ATP	"SRR"	"SDR"	"PDR"	"CDR"	"MRR"	Manufacturing	A&T	Launch
Subcontracts									
'Ilities									
Propulsion									
Program Management									
Systems Management									
Mechanical Design									
Electrical Design									
Manufacturing									
Assembly & Test									
Ground Support Equipment									
Software									

Figure 2. Top-Level Process Flow Mapped Work Area Tasks Against Program Milestones

Object-Oriented Productivity Metrics

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Software productivity metrics are useful for sizing and costing proposed software and for measuring development productivity. Estimating and measuring source lines of code has proven to be a bad idea because it encourages writing more lines of code and using lower level languages. Function Point Analysis, as espoused by Dreger [1], is an improved software metric system but it is not compatible with newer rapid prototyping and object–oriented approaches to software development. A process is presented here for counting object–oriented effort points, based on a preliminary object–oriented analysis. It is proposed that this approach is compatible with object–oriented analysis, design, programming, and rapid prototyping. Statistics gathered on actual projects are presented to validate the approach.

Problems With Existing Productivity Metrics

The software engineering field has been searching for decades for a way to definitively size software. The purpose of precise sizing of software is to provide a means for determining, exactly, the answers to the following questions:

- How much will it cost to develop a proposed new software application?
- How well will the software fit within the target computer's available storage and memory?
- How are individual programmers performing in terms of units of software produced per unit of project time elapsed?
- When will the work in progress be ready for use?

Good metrics would make new application cost/benefit analyses lead to correct decisions more frequently. There would be less processing of expensive change requests during system development to reconfigure baseline hardware architectures as true software size becomes apparent. Total Quality Management (TQM) programs could make use of better process improvement metrics. Project management, with good metrics, would be more effective.

The most prevalently used metrics are heuristics based on experience; experienced software developers are sometimes pretty good at guessing the answers to the four preceding questions. The second most widely used metric is the Source Line of Code (SLOC); developers guess how many SLOCs will be in the final product and then multiply the error of this estimate by errors in the estimate of how many lines of code can be produced in one person hour. Less widely used is Function Point Analysis [1] — a measure of software size that is language independent and has a more precise definition than the SLOC.

The argument can be made that estimates based on experience are not really metrics at all. A counter to this is that most existing software productivity metrics are also fairly unscientific, but are disguised to appear scientific. In fact, there is little conclusive evidence that use of any of the current metrics will produce any more accurate results than experience based estimates. Following are the specific disadvantages of using SLOCs or FPA metrics for your next software development project.

Source Lines of Code (SLOC) Metrics Discourage Productivity

Software developers are paid to develop software applications, not to write lines of code. Suppose that two developers are working on the same application in different organizations. One is using a third generation language (3GL), such as FORTRAN, and another using a fourth generation language (4GL), such as an SQL dialect. The 4GL developer will have fewer lines of code than the 3GL developer (by one order of magnitude) for the same amount of functionality. This is documented by many studies and is well presented in Dreger's Function Point Analysis [1].

This fact is complicated by several arguments. Some argue that 4GL code is not as efficient or robust as 3GL. Others say that, although the 4GL programmer writes fewer lines of code, s/he is done sooner, so the metrics work out satisfactorily. Finally, some advocate collecting SLOC metrics that are language specific, thus compensating for differences.

It is not necessary to argue over the goodness of 4GL versus 3GL. Do you believe that third generation languages were a significant productivity improvement over second generation languages such as Assembler and Autocoder? Wasn't Assembler a big improvement over raw machine language? Isn't there a noticeable trend here in terms of number of lines of code needed to produce a given amount of functionality? The history of programming environment development has always been to create new languages that increase programmer productivity by requiring *fewer lines of code* to produce a given amount of functionality. If you use a metrics system that rewards programmers based on how many lines of code they write per hour, you will be implementing a bad incentive (rewarding productivity degradation).

While it is true that 4GL programmers will finish coding a given amount of functionality sooner than their 3GL programmer counterparts, this does not mean that they will finish a similar development project significantly faster. The reason this is true is that they will not write requirements and design specifications or test plans any faster. Suppose that coding is 20% of total development effort. Then, suppose that a 4GL programmer can do the coding in 10% the time required for a 3GL programmer. This will result in a total 18% productivity improvement — not very dramatic. On the other hand, the 4GL programmer will probably write 10% of the number of lines of code needed by the 3GL programmer. Therefore, a SLOC metrics system will show that a 4GL programmer is very unproductive, compared to a 3GL programmer — unless the organization has been collecting 4GL metrics previously and never attempts to compare productivity between environments. The bottom line is that, even if you collect 4GL metrics, there are always vendors out there developing new higher productivity languages and development systems. Consider how badly SLOC systems fail in visual programming environments where icons, menu choices, and drawing tools take the place of text-based syntax.

Function Point Analysis (FPA): Improved, but Short of Ideal

FPA requires estimating how many Inputs, Outputs, Queries, Files, and Interfaces a proposed system will contain. An Input is basically a program that is mostly about capturing data. An Output is a program that mostly issues data. Queries are combinations since they require a fair amount of input and always produce output. Files are static data storage locations, including database tables. Interfaces are external entities: other applications, users, and devices.

In his book, Dreger presents a scheme for identifying and classifying each of these elements as to their complexity and assigning each element a number of Function Points depending on its complexity. He, of course, recommends collecting your own data to use in converting Function Points to hours, but does give some examples so that you can see that a good starting place, if you have not been collecting data, might be about 20 hours per Function Point in a typical 3GL environment. The beauty of this approach is that it is language independent; you will develop the same number of Function Points regardless of which language you choose.

FPA rewards productivity realized from using more advanced development tools by producing statistics that show more Function Points being created in fewer hours. It is true you must still estimate how many Inputs, Outputs, Queries, Files, and Interfaces a proposed system will contain, and then multiply the error of that estimate by the error in conversion to hours, but conventional structured analysis and design (SA/SD) methodologies will produce specifications from which these estimates can be rather precisely extracted. For this reason, FPA estimates based on fairly complete structured specifications, have proven to be much more accurate than the average SLOC based estimate.

Unfortunately, the very reason for the success of Function Point Analysis is also its major weakness. Since structured specifications must be fairly complete before a meaningful estimate can be generated, FPA does not work well when a rapid prototyping approach such as that recommended in Structured Rapid Prototyping [2] is used. The rapid prototyper needs a reliable estimate in order to plan for when prototype iteration must be complete, but does not want to completely pre-specify requirements before they have been discovered through prototyping.

Also, it is not clear that FPA is compatible with modern Object–Oriented development techniques. In the Object–Oriented paradigm, the concept of *Program* (Inputs, Outputs and Queries) is obsolete, as is the concept of *File*. These archaic concepts are replaced with the new term *Object*. An Object encapsulates both data (as Object attributes), and methods, or services (what the object does). The best of the new Object–Oriented Analysis methodologies [3] do not provide a means of developing specifications from which Function Points could be easily derived.

Introducing Object-Oriented Productivity Metrics (OOPM)

The following material presents something new — Object–Oriented Productivity Metrics (OOPM). This is an approach that, similar to FPA, is language independent, but is also very compatible with Object-Oriented Analysis and rapid prototyping. The developer using OOPM will be counting Object–Oriented Effort Points (OOEPs) instead of Function Points. An OOEP is intuitively straightforward, it is a unit of measure used to determine how long it takes to develop an Object Class.

In order to determine how long it will take to develop a new Object Class, you will need to specify how many attributes the Object will have, how many services or methods of various types it will contain, what external entities it will get data from, and to what external entities it will deliver data. Objects will be simple, average, or complex depending on how many attributes they have. A simple Object might be defined as one with fewer than seven attributes. An average Object would perhaps have seven to 14 attributes, and complex Objects would have greater than 14 attributes. This classification is similar to and based on Dreger's system [1] for classifying the complexity of files, except that files usually have significantly more fields than Objects have attributes [3].

Experience on actual projects shows that most of the time spent developing the data structure of an Object Class is spent in requirements analysis and design. Actual development of data structure instantiation scripts takes almost no time once the design details have been specified. This is why it is important to classify Objects as to their data complexity. Then give simple Objects 3 OOEPs, average Objects 5 OOEPs, and complex Objects 8 OOEPs — an assignment similar to FPA File classification.

Services, or methods, should be counted separately, as each one will contribute significantly to effort required to implement an Object Class. Here you could classify Services into four categories, consistent with both Dreger [1] and Coad/Yourdon [3]: Add/Modify/Delete Services, System Screen (Menus, Helps) Services, Output Services, and Computationally Intensive Services. Some of these categories would be further classified as simple, average, or complex, depending primarily on how much data is processed. Add/Modify/Delete Services could get 3,4, or 6 points, and Output Services 4, 5, or 7 points. System Screen Services, such as menus and help screens, do not normally process data, so they would always get the same number of points, say 4. One would classify services as computationally intensive so that they will always get a high number of points, regardless of amounts of data processed, say 8.

Finally, count the external entities the proposed application will have to interface with, similar to the Interface count in FPA. Classify external entities as simple, average, or complex depending on how many Object Classes the external will interface with. Give less than two Classes 7 points, two to five Classes 10 points, and more than five Classes 15 points. Figure 1 summarizes the system for classifying Object–Oriented Effort Points.

	Simple	Average	Complex
Object Class	< 7 Attributes	7 - 14 Attributes	> 14 Attributes
	3 OOEPs	5 OOEPs	8 OOEPs
Service:			
Add/Modify/ Delete	3 OOEPs	4 OOEPs	6 OOEPs
Output	4 OOEPs	5 OOEPs	7 OOEPs
Sys. Screen	4 OOEPs	N/A	N/A
Comp. Intense	N/A	N/A	8 OOEPs
External Entity	< 2 Classes	2 - 5 Classes	> 5 Classes
	7 OOEPs	10 OOEPs	15 OOEPs

Figure 1, Object-Oriented Effort Point Classification System

Using Object-Oriented Analysis to Count OOEPs

What the OOPM estimator will need to do at the start of a new software development project is to prepare a preliminary requirements specification, using graphic models depicting the Object Classes, Services, and External Entity Interfaces the new application will need. This can be very incomplete, for a rapid prototyping project, and an expansion factor applied to the initial estimate to obtain a total development effort estimate.

For rapid prototyping, OOPM will work better than an FPA approach based on SA/SD because there will be a direct correlation between expansion of the OOA specification and expansion of the prototype — more Object Classes and Services will be added with each prototype iteration. With SA/SD, expansion of a prototype resulted in more primitive processes to specify in the Structured Analysis, requiring re-partitioning and balancing of all higher levels in the Dataflow Diagram hierarchy. This is what is recommended in *Structured Rapid Prototyping* [2] — possible, but somewhat awkward.

Figure 2 shows an example of an Object–Oriented information model diagram for a Harbor Information System. This application will contain ten simple Object Classes for an OOEP count of 30. It will contain 6 simple Add/Modify/Delete Services for 18 OOEPs, 4 simple Output Services for 16 points and, let's say, one menu and one help screen, for 8 more points. This gives a total of 72 OOEPs.

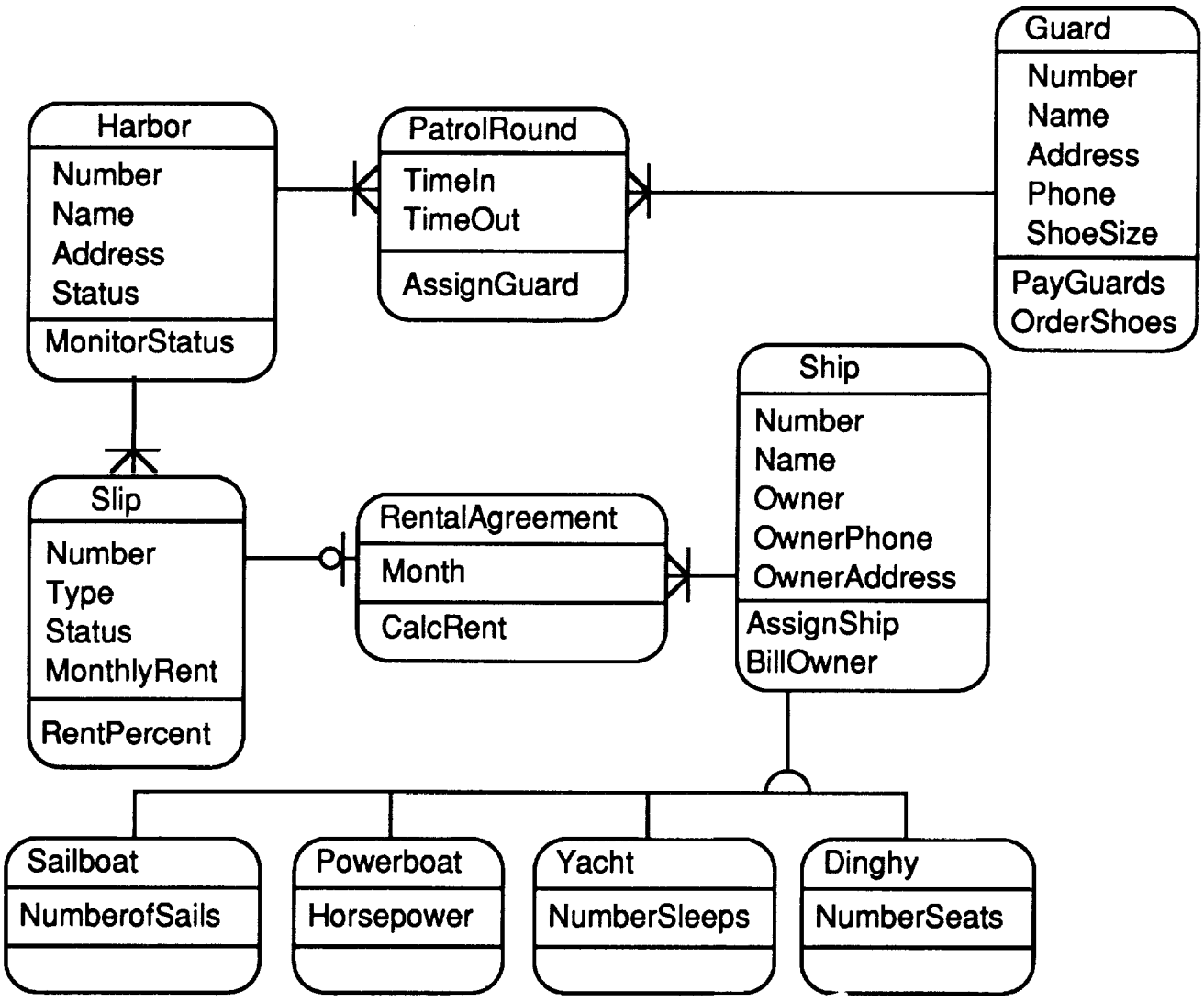


Figure 2, Harbor Information System Object-Oriented Information Model

But, what about External Entity Interfaces? In Structured Rapid Prototyping, [2] two dataflow diagrams, The Context Diagram and the Essential Functions Diagram, are recommended as part of the preliminary rapid requirements analysis to help work out the external data interfaces. How to model these interfaces seems to be missing from the Coad/Yourdon OOA approach. On the other hand, it does not seem appropriate any longer to advocate that an Object–Oriented developer begin by drawing Dataflow Diagrams. Instead, consider an Object Class Source/Sink Diagram as shown in Figure 3.

In Figure 3 there are 5 external entities. Harbor Manager and Employee are of average complexity and get 10 points each. Acme Placement Agency Database, Ship Owner, and Payless Shoes are simple and get 7 points each. The total External Interface OOEPs are 41. This brings the grand total for the Harbor Information System to 113 OOEPs.

Hours per OOEP

In Function Point Analysis [1], Dreger states that the norm for hours required to code one Function Point, in a third generation language, such as COBOL is about 20. Examples given of languages in this range are Pascal, JOVIAL, FORTRAN, COBOL, ALGOL and C (C is identified as the least

productive language in this list). Object–Oriented software development projects will not use one of these languages; they will hopefully use an Object–Oriented Programming Language (OOPL) such as Smalltalk or C++. Dreger says that such languages will require about one-fifth as many lines of code per Function Point as a third generation language. Presumably this is due to language extensibility and component reuse through inheritance. This puts an OOPL in almost the same category as a 4GL — about 4 hours per Function Point.

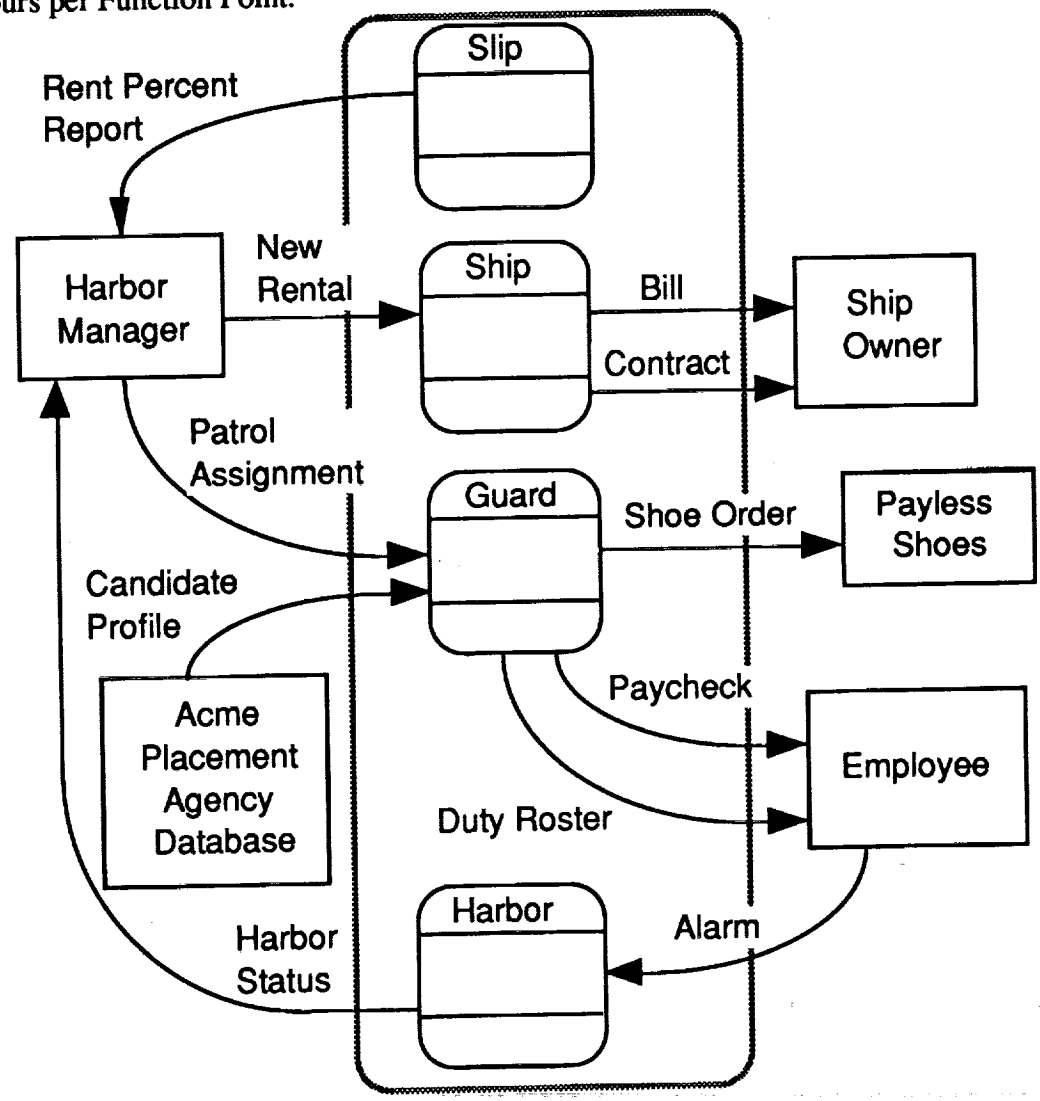


Figure 3, Harbor Information System Source/Sink Diagram

From this analysis, it can be determined that, using OOPM, a simple Add/Modify/Delete Service (data entry screen) should take an average of about 12 hours of effort (3 OOEPs times 4 hours per OOEP). The conversion of 4 hours per OOEP can be applied to all 113 OOEPs for The Harbor Information System, which then should take about 452 person hours to develop. This estimate should include OOA, OOD, programming with an OOPL, test and all documentation. Keep in mind that documentation effort is one of those aspects of development that will vary widely according to various organizations' documentation standards and that all such estimates will need to be adjusted to specific project conditions, such as developer skills and experience.

Benefits of Using Object-Oriented Productivity Metrics

The metrics presented here will be compatible with, and encourage the use of, very advanced development environments such as those used in Object–Oriented Rapid Prototyping [4]. Developers will be rewarded according to their proficiency in rapid development of new Objects (something of more perceived value to application users than lines of code or Function Points). Software reuse, an important modern productivity enhancing technique is fostered by Object–Oriented techniques; it will be rewarded by Object–Oriented Productivity Metrics. OOPM will generate metrics that are tightly coupled to Objects. When those Objects are reused, their OOEPs are encapsulated and will move with the Objects to the new environment where they become available for processor sizing and other purposes.

Whether or not rapid prototyping is used, OOPM provides a way to get reliable sizing and effort estimates very early in the project — before requirements have been finalized — based on preliminary Object–Oriented graphics models. When using a rapid prototyping approach, OOPM will provide an estimate of how long it will take to develop the initial prototype and an expansion ratio can be used to estimate how long it will take to develop the entire application. The same expansion ratio can also be applied to estimate how many Objects will exist in the final application.

Research Evidence Supporting Feasibility of OOPM

Dreger has been cited as a source of valuable software metric research [1] and Coad/Yourdon OOA [3] has been cited as a good approach to Object–Oriented requirements analysis. The basic philosophy of FPA is that software metrics should be based on things the user wants to pay for, not lines of code. The basic philosophy of OOA is that users are mostly interested in Objects within the domain of their field of interest. It seems logical, therefore to merge these two philosophies to create Object–Oriented Productivity Metrics.

Attempts at defining what a software Object is, to the universal satisfaction of all software engineers, have mostly met with failure. Undaunted, we will propose one more definition: an Object is a thing of interest to a software application user — defined, for the purposes of that application, by the attributes of the Object that are of interest to the user.

The reason this working definition of an Object is useful is that it allows for comparisons that may tie OOPM back to FPA for purposes of supporting feasibility. An Object has attributes; in terms of Information Modeling methodology, so does an Entity. In implementation, an entity often becomes a database table. Thus, Object attributes are very similar to database attributes which are, in turn, very similar to fields in files (except that database tables are usually normalized and have fewer attributes than files have fields). Therefore, FPA File counts can be converted to OOPM Object counts.

For FPA, SA/SD methodologies are used to provide precise counts of how many files will be created for a new application. For OOPM, you can use OOA models to accurately determine how many Objects of what level of complexity will be created. Determining Object complexity from preliminary OOA models may, in fact, be easier than determining File complexity from preliminary Structured Analysis. It is difficult, during the early stages of requirements analysis, to determine how many fields will be in a proposed file. It is not so difficult, in the early stages of OOA, to determine how many attributes a proposed Object will have.

One of the authors is the manager of several projects at NASA Ames Research Center that have been collecting metrics on application development in an environment using Sybase development tools. Sybase is a relational database management system with a bundled collection of development tools including a 4GL, reportwriters, and a forms generator. On these projects, entities are defined and modeled in a manner consistent with defining and modeling Objects in OOA (even though Sybase is not Object–Oriented).

The metrics kept are with respect to how long it takes to develop a Form and how long it takes to develop a Report. Only development with Sybase tools is tracked; very little development work on these projects uses third generation language programming. Four years of data have been averaged with the result that it can be stated that the average Form takes 24 hours to develop and the average Report 16 hours. There is a variance, depending on complexity, yielding a range of 4 to 40 (sometimes more) hours per Screen and 4 to 24 hours per Report. These metrics do not include final system documentation or full integration testing.

Some of the Screens are very complex. They include what has been described above as Add/Modify/Delete Services, System Screen Services, and Computationally Complex Services. The Reports are equivalent to the Output Services described above. Data has not been kept on the amount of requirements and design effort required to develop an Entity (Object).

The purpose of reporting these effort metrics here is that they fall well within an acceptable range of the suggested values for OOPM given above. Suppose that the average input Service is worth 4 OOEPs and the average output Service 5 OOEPs. Then suppose, using Sybase tools, an OOEP takes 4 hours to develop (this would be consistent with statistics provided by Dreger [1]. Then, developing an input Service would require an average of 16 hours and an output Service 20 hours, according to OOPM metrics. These estimates are acceptably close to the actuals of 24 hours and 16 hours, respectively, considering that Dreger says the average of 20 hours per COBOL Function Point has a range of 3 to 87 hours. To get really accurate metrics, you will have to collect your own statistics.

Summary of Findings

With the advent of rapid prototyping; Object–Oriented Analysis (OOA), Design (OOD), and programming (OOP); and, recently, Object–Oriented Rapid Prototyping (OORP) — it is time to abandon software productivity metrics based on either Source Lines of Code (SLOCs) or Function Point Analysis (FPA). Productivity metrics need to support and encourage the use of the best modern software engineering practice if the desired result is continuous process improvement.

A new approach, Object-Oriented Productivity Metrics (OOPM) has been defined here that is compatible with modern software development techniques such as Object–Oriented Rapid Prototyping. Arguments made in and supported by Coad/Yourdon's Object–Oriented Analysis [3] and Dreger's Function Point Analysis [1] provide proof of the soundness of the OOPM approach. Actual project experience, using metrics similar to those that would be used with OOPM, provides evidence indicating that OOPM based estimates would be highly accurate. Based on this research, the following recommendations can be made without hesitation:

- Use OOA, OOD, and OORP techniques for software development.
- Estimate effort using OOPM.
- Evaluate productivity using OOPM.
- Collect your own OOPM statistics and continually refine them over time.

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1. Coad, P. & Yourdon, E. *Object-Oriented Analysis*, New York: Yourdon Press (Prentice-Hall), 1990, 1991.

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3. J. Brian Dreger, *Function Point Analysis*, Prentice Hall, Englewood Cliffs, NJ, 1989.

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D4 Planning and Organizing for TQM Integration (Continued)

This panel presents approaches used by organizations involving the long-term strategy of planning for TQM integration and the necessary education and training.

Karen S. Messinger, Manager, Total Quality Projects, Pratt & Whitney, United Technologies Corporation, **"Successful TQM Equals Q+ at Pratt & Whitney."**

J. Jeannette Eads, Manager, Total Quality Management, EG&G Florida, Inc., AND **Dr. Dennis C. Kinlaw**, Senior Partner, Kinlaw Associates, **"Kennedy Space Center's NASA/Contractor Team-Centered Total Quality Management Seminar: Results, Methods, and Lessons Learned."**

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SUCCESSFUL TQM EQUALS Q+ AT PRATT & WHITNEY

Ms. Karen Messinger
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1.0 Q+ BACKGROUND

In 1985, Pratt & Whitney initiated implementation of a comprehensive quality improvement effort called Quality Plus (Q+) to incorporate the following quality fundamentals into our culture:

- **Conformance to requirements.**
- **Prevention** of defects rather that detection
- Link quality and productivity by **"Do it right the first time"**
- Conformance to requirements must be measurable. **Measurements** allow priorities to be established, corrective action initiated, progress evaluated, and effective business decisions to be made.
- **Customer and supplier partnerships** that mutually benefit from improvement opportunities thru elimination of internal barriers between functional organizations and external barriers between P & W and our customers and suppliers.
- **Involvement** of the appropriate people results from adopting a team approach to improvements
- **Continually improve** our processes and products.

This effort evolved, along with other quality initiatives, into a 3 Phase strategy to integrate Total Quality into Pratt & Whitney's business.

2.0 TOTAL QUALITY STRUCTURE

Foundation

After the launch of Q+ in 1985, management established an organization that coordinated Q+ efforts within the existing organizational structure. During this Phase I of Q+, an executive level Steering Committee planned, guided, coordinated and reviewed the Q+ process. Creation of an

executive staff position, Q+ Manager, provided a liaison for customer questions and catalyst for strategic planning of Total Quality. Q+ Teams, consisting of a cross-section of employees, setup and managed quality systems, such as Education/Awareness, Communications, Reward & Recognition and Employee Suggestion Systems, in each major department. Each Organizational Leader designated a Q+ Coordinator to act as the link between the Q+ Team, Department Management and the Q+ Manager.

After 2-1/2 years of culture change and building a quality foundation, the Q+ focus evolved to process improvement. During 1988, Phase II of Q+ formally brought process improvement to P&W. Management now became directly responsible for leading the process improvement effort. The Q+ Steering Committee continued to guide the overall GESP TQ efforts. A Leadership Council, consisting of top management, acted on improvement opportunities identified by employees. These opportunities led to successes such as our current Employee Development process. Q+ Teams continued to manage and improve quality systems in their respective departments. Process Improvement and Measurement were added as quality systems managed by the Q+ team, providing additional systems for addressing local improvement opportunities. Q+ Coordinators and the Q+ Manager continued to provide a support structure and expert resource for Q+.

Phase III Structure

Total Quality Council

Phase III Q+ aligns the Total Quality and Organizational Structure so quality initiatives and fundamentals are easily incorporated into the business plan and employees daily work routine. As part of the transition, the Leadership Council and Q+ Steering Committee combined to form the Total Quality Council (TQC), consisting of Senior Management, which is responsible for leading the Total Quality effort. Their role is to review and recommend TQ Strategy. The TQC champions the division level cultural, technical and process quality initiatives. They monitor the progress, provide direction and executive leadership for quality initiatives. These Senior level Managers actively partner with Q+ Coordinators to improve the communication, leadership, rewards & recognition and process improvement systems at Government Engines and Space Propulsion (GESP), a P&W division. They assess GESP total quality performance through division level quality metrics and have also teamed with Q+ Coordinators & Facilitators to design the Phase III Management Workshop. The TQC initiated and led activities ranging from clarification and simplification of Policies and Procedures to sensitive issues such as Employee Morale and Diversity. Regular communications of the division's business plan from Senior Management to employees is given through Employee Business Updates (EBUPs) which are reviewed by the TQC.

Department Quality Councils

At the functional level, Department Quality Councils (DQCs) have been formed to take responsibility for incorporating Total Quality (TQ) into their Department Business Plan. DQCs typically consist of key department managers who have the responsibility and authority to make decisions on the department business and culture. The DQCs role is to demonstrate and role model management accountability for TQ by integrating previously separate quality initiatives in with the department's regular business. The goal is to plan and execute improvements to the departments products/services by using the quality systems, teaming concepts and quality tools and techniques in conjunction with employees' expertise, allowing achievement of the division business goals. In Phase III, the DQC becomes responsible for managing the quality systems and the workforce now supports the Department Quality Plan by actively participating on Process Improvement Teams or Quality Systems Committees linked to the Quality Plan or by simply applying the tools and techniques in their daily tasks. The emphasis of each DQC is to lead the Process Improvement effort, provide resources for effective teaming, practice participative management, empower employees to make decisions and maintain open communication with employees. These actions are making our quality systems much more powerful.

Measurement Activities

One of the DQC's key accountabilities is to manage the department's Quality Plan with Quality Metrics. DQCs are expected to role model the use of measures by setting goals, managing their actions with appropriate organizational measures and coordinate the communication and publication of these measures. Progress to each department's goals are reviewed regularly by executive staff. In order to ensure Customer Involvement, DQC's are beginning to validate their measures with their customers and are checking that all teams have actively involved their customers in defining measures. Overall, measurements are now being used as a basis for reviewing and making decisions on the Improvement progress towards the department's goals.

Lessons Learned

Throughout Phase I & Phase II of Q+, the workforce was responsible for managing the quality systems and while management was accountable for support and commitment to Q+. In Phase III, Management is responsible for developing strategies to improve the quality of the department's products and services through the DQC and using the workforce's expertise of the established quality systems. When company leaders manage quality improvements it becomes real business; this sends a message to the workforce that Q+ is the way we work. Continuation

of the Q+ Coordinators provides a focal group to advise and assist the DQCs & TQC in the application and integration of quality into the business.

Also, in Phase III, we continue to have an active Total Quality Council, which addresses division level TQ activities. The TQCs active status demonstrates the real long term commitment to TQ needed to direct GESPs TQ strategies.

3.0 TRAINING

Awareness

During Phase I Q+ massive awareness training was necessary to initiate the new concept of team effort. Executive teams established Q+ goals and an implementation plan. Meanwhile, department level Q+ teams began to educate employees in the fundamentals of a quality culture, how to use the quality systems and to ensure that each employee had the opportunity to obtain the skills training required to identify and act on quality improvement activities. Department Q+ teams provided Awareness sessions to make employees aware of these fundamental principles.

Problem Solving and Advanced Tools

As the TQ culture progressed, specific problem-solving training prepared employees to lead problem solving teams. Process Improvement Advisor/Facilitator training produced advisors with the ability to conduct workshops for managers/teams on methodology and tools needed to identify and perform process improvement. Management attended Leadership skills training to improve the quality of leadership, delegation skills and creation of a shared vision for the departments. As P&W progressed into more complex quality improvements, training of advanced problem solving tools, such as Taguchi methods, Quality Functional Deployment (QFD) training and statistics courses, were offered to employees. These skills are being used by a variety of employees and teams to improve upon the department and the company's products/services enabling the use of TQ tools and techniques to become integrated into the workplace.

Total Quality Leadership

Phase III Implementation training prepares and assists organizational leaders and the DQCs for managing and improving the TQ Improvement effort within their organization. This workshop provides them the opportunity and direction for identifying actions they need to take in order to focus the TQ efforts on the department's mission. It also guides them to integrate current and planned TQ initiatives with their business plan. One of the products produced during the Management Workshop is management actions required for creating a successful environment of manager/employee teams and for setting the stage for transition to employee self-directed work teams that implement quality improvements in their respective processes.

Lessons Learned

Training is critical for all levels of the organization. Everyone needs the skills and tools required to integrate Total Quality. Employees and managers need to be able to identify the actions and expectations required of them in order to continually improve the processes that we work.

A key training lesson is to apply a "Learning by doing" concept in place of "Learning by example", using business applications.

4.0 CUSTOMER INVOLVEMENT

Background

The 'great engine war' prompted Pratt & Whitney to commit to Q+ in order to improve customer satisfaction and therefore increase the amount of business received. During Phase I, our focus was to clarify the customer's needs and seek feedback from the customer. Improvements made by candid communications with the customer ensured requirements were met and program developments were effectively responded to. A customer awareness campaign was initiated through Q+ that identified both internal and the ultimate customer. We started to recognize our suppliers as customers who rely on P&W's ability to effectively communicate requirements to them and that they are a key ingredient in the cost and reliability factor that affected product quality. During Phase II, we began to actively involve our customers and suppliers in improving our business processes. Emphasis was on customer partnerships through joint customer process action teams, customer participation in Q+ initiatives and sharing Q+ information and training.

Phase III Customer Involvement

Integrating Q+ requires us to have continued emphasis on customer partnerships and to now include customer satisfaction indicators in our business plans. Our plan is to have the DQCs identify the department's key products/services, the direct and indirect customers of these products/services, then validate and negotiate with the customer the satisfaction indicators for the product/service. These indicators will be used to identify key processes for improvement. For the products/service indicators that require improvement; improvement efforts will be initiated with input from the customer. Any teams that evolve from these improvement efforts will have customer participation. Individuals and Teams should agree upon requirements with "customers" prior to beginning tasks and ask for feedback from "customers" upon completion of tasks.

Lessons Learned

Customer partnerships are key vehicles to meeting our customers requirements on time and within budget. Customer Input is required in the identification of potential improvement opportunities so that we choose to improve those processes important to the Customer. Customer Involvement in improvement initiatives is essential to ensure that incorporated improvements will continue to meet the established requirements.

5.0 EMPLOYEE INVOLVEMENT

Background

With any TQ initiative, a goal is to empower the workforce to exercise self-direction while continuously identifying and pursuing improvement strategies in routine work. In Phase I of Q+, the Search for Opportunities and Corrective Action process gave employees the chance to participate by offering improvement suggestions and as members of problem solving teams. This started the cultural change needed to allow open communications between employees and management and for employees to know that they can make a change in the business.

During Phase II, the employee role evolved to active team problem solving. A more comprehensive approach to quality transitioned from problem solving to focusing on improvements to overall processes. Teaming to improve processes allowed employees to take an active role in the processes they use on a daily basis.

Phase III

By establishing ownership and defining processes, employees are more involved in improving the quality of their products and services. Phase III requires that process improvement and measurement is a normal part of the job. Through education and measurements , employees are aware of the potential wastes and can determine from appropriate measurements how to justify and validate further changes. In this Phase of Q+, individual employees and teams are encouraged to identify barriers to performing their jobs to management. Understanding and working on teams has now become second nature to employees. Continuing to encourage employees to work together in a non-adversarial environment and make conscientious, objective work related decisions is key to keeping employees involved.

Lessons Learned

The environment for employee participation has to allow employees to step out of the traditional functional lines of communication to improve matrix organizational processes. Employees have great knowledge of the processes associated with their job; management must know how to use that knowledge for improvement, and also know how to set expectations for teams and remove barriers for teams or individuals. Management must also evaluate when to have a team versus an individual effort to solve a problem or make an improvement. A key lesson is to let employees make or suggest improvements to processes that affect their work. When working as a team, team membership is very important and using a third party facilitator can keep a team from getting stuck.

6.0 CONCLUSION

Many significant results have been realized from the TQ effort over the past seven years; most as a result of the continued focus on continuous improvement and our customers. Using these lessons learned to integrate TQ, Phase III of Q+ at GESP will emphasize teamwork, leadership and commitment from the total organization. Management will be directly involved in planning quality efforts and ensuring that reward & recognition systems promote the new values that ensure quality improvement efforts are part of the business and an employee's regular job function.

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Kennedy Space Center's NASA/Contractor Team-Centered Total Quality Management Seminar: Results, Methods, and Lessons Learned

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Introduction

It is apparent to everyone associated with the Nation's aeronautics and space programs that the challenge of continuous improvement can be reasonably addressed only by NASA and its contractors acting together in a fully integrated and cooperative manner that transcends the traditional boundaries of proprietary interest. It is, however, one thing to assent to the need for such integration and cooperation; but it is quite another thing to undertake the hard tasks of turning such a need into action.

Whatever else total quality management is, it is fundamentally a team-centered and team-driven process of continuous improvement. The introduction of total quality management at the Kennedy Space Center, therefore, has given the Center a special opportunity to translate the need for closer integration and cooperation among all its organizations into specific initiatives.

One such initiative that NASA and its contractors have undertaken at the Kennedy Space Center over the past six years is a NASA/Contractor team-centered Total Quality Management Seminar. It is this seminar which is the subject of this paper.

The specific purposes of this paper are to describe the:

- Background, development, and evolution of Kennedy Space Center's Total Quality Management Seminar;
- Special characteristics of the seminar;
- Content of the seminar;
- Meaning and utility of a team-centered design for TQM training;
- Results of the seminar;

- Use that one Kennedy Space Center contractor, EG&G Florida, Inc. has made of the seminar in its Total Quality Management initiative; and

- Lessons learned.

Background

During the period of NASA's Productivity Improvement and Quality Enhancement (PIQE) Program, Dennis Kinlaw designed a seminar for delivery to the Agency's civil servants called the Productivity Improvement and Quality Enhancement Seminar. In 1986 KSC asked Kinlaw to modify the seminar for delivery to NASA and NASA contractors.

Since 1986, The seminar has undergone a series of revisions. A major revision occurred in 1988 when the seminar was modified to focus on teams and team development. Since 1988 all participating organizations have been expected to send only teams to the seminar.

To date over 5,000 people and over 150 teams have attended the seminar. Participating organizations have included all NASA KSC organizational elements, Boeing Aerospace Operations; EG&G Florida; Grumman Technical Services, Inc.; Lockheed Space Operations Company; McDonnell Space Systems Company; PRC; Rockwell International Corporation, Space Systems Division; Rockwell International Corporation, Rocketdyne Division; TRW; Thiokol Corporation; and USBI. This year members of the U.S. Fish and Wildlife Commission on KSC's Merritt Island National Wildlife Refuge requested to attend the seminar and we have had two teams to date.

The various kinds of teams attending the seminar have included:

Intact Work Teams - groups of people from the same company or organization who daily work together and who, most often, have a supervisor or lead.

Management Teams - a manager and his/her staff and direct reportees including secretaries, deputies, technical assistants, etc.

Integrated Teams - members from various internal and/or external organizations that must work together across various organizational interfaces.

Project Teams - people put together to produce some specific product within a designated period of time.

Special Improvement Teams - quality action teams, quality circles, process improvement teams, TQM teams, etc.

Network Teams - people who work together, share information, participate in related tasks, but who may rarely see each other, e.g. the network of secretaries that link

together all sorts of processes and actions in organizations.

Committees and Councils - permanent and temporary groups like EEO councils, source evaluation boards, awards committees, child care committees, promotion boards, etc.

Special Characteristics of the Seminar

The seminar has a number of special characteristics. It:

1. is team-centered, i.e., designed for team-learning, team management, and team implementation.
2. employs trained facilitators with each team;
3. uses senior executives as presenters;
4. provides the opportunity to share information across multiple organizations;
5. requires pre-seminar preparation;
6. uses a process of team assessment and feedback;
7. uses input from teams having previously attended the seminar;
8. encourages post-seminar team action.

Team-Centered

The most important characteristic of the seminar is that it is team-centered. The meaning of team-centered is covered in a later section of this paper.

Trained Facilitators

Each team attending the seminar is expected to bring a facilitator who has been trained in the dynamics and content of the seminar. These facilitators have responsibilities before, during, and after the seminar.

Uses Senior Executives as Presenters

Each seminar starts with a presentation from a senior executive from NASA or a KSC contractor. The presentations typically serve the following purposes:

Demonstrates the commitment of the executive and his/her organization to TQM;

- Demonstrates the commitment of the executive and his/her organization to KSC's TQM Seminar;

- Provides participants with information about the implementation of TQM in the executive's organization; and

- Provides participants with an opportunity to ask questions and clarify their own understand of TQM.

Provides the Opportunity to Share Information Across Multiple Organizations

Another characteristic of the seminar is that it is designed to help participants learn about the progress of TQM in other organizations at KSC--beyond their own. The participation of senior executives from the various organization is one way that information is shared. In addition, on the second day of the seminar, presentations are made by a TQM representative from an organization (other than the one represented by the senior executive who presents on the first day).

Pre-Seminar Preparation

Participants are expected to complete several tasks before attending the seminar. They are assisted in completing these tasks by the facilitator assigned to their team. These tasks include:

1. Completing a set of questions related to TQM and continuous improvement;

2. Completing the *Superior Team Development Inventory* (Part 3);

3. Familiarizing themselves with the content of the seminar as described in the *Participant Notebooks*.

Team Assessment and Feedback

As indicated above, prior to attending the seminar, the members of each team complete the *Superior Team Development Inventory* (Part 3). The particular instrument that has been used has varied over the years, but from the beginning of the seminar assessment and feedback have always been a key element in its design.

Uses Input from Teams Having Previously Attended the Seminar

As the seminar progressed and developed its own history, we began to invite teams (that had attended the seminar earlier) to give a brief report of their progress since attending the seminar. These teams are asked to emphasize two key points: what specific improvement projects have been undertaken and what lessons have been learned.

Post-Seminar Team Action

During the seminar each team completes an *Action Plan*. The specific targets included in this plan are derived from the various exercises and activities that each team goes through during the seminar. These reports permit the progress of teams to be followed and periodic evaluations to be made of the effectiveness of the seminar.

Present Content of the Seminar

The core sessions of the seminar are:

I. TEAM-CENTERED TOTAL QUALITY MANAGEMENT

In Session I the need and payoffs from TQM are discussed. The Team-Centered TQM Model is introduced. Participants develop a common understanding of TQM.

II. KEYS TO SUPERIOR TEAM DEVELOPMENT AND PERFORMANCE

The Superior Team Development and Performance Model is introduced. Participants assess their work team's levels of team development and performance using the *Superior Team Development Inventory (STDI)*. They translate the results of their assessment into an improvement *action plan*.

III. SPECIAL TQM METHODS AND TECHNIQUES

This session introduces participants to several methods and techniques for strengthening team development and improving TQM performance. The specific methods and techniques covered will vary depending on current need. Example include, work simplification, statistical process control, rational problem solving, nominal group technique, assessment and measurement, and customer needs analysis.

IV. CONTINUOUS IMPROVEMENT AND MEASUREMENTS

In this session a Model for Continuous Improvement and Measurement is introduced. Teams participate in several exercises in which they identify opportunities for continuous improvement and develop measure for tracking these improvements.

V. PLANNING TQM INITIATIVES

Throughout the seminar, participants identify improvement opportunities. During the last session of the seminar, participants make specific plans to undertake these improvements opportunities on the job.

The Meaning and Utility of a Team-Centered Design for TQM Training

The typical function of training in TQM programs is to build the competencies in people that they require for undertaking their responsibilities for the continuous improvement of quality. Even when such training focuses on team leadership and team membership, participants are largely expected to make their own individual application of their learning. In a team-centered design (like the one used in KSC's TQM Seminar) the function of training is vastly different and enlarged. The general characteristics of team-centered training are:

- Learning focuses on the primary unit of performance, i.e., groups of people vice individuals;
- Participants learn with the people with whom they will apply their learning;
- Participants become mutually responsible for the learning of each other;
- Team application of learning is planned by the team during the seminar;
- Each team engages in real time team development during the two days of the seminar; and
- The total organization's capacity for team development and continuous improvement is strengthened.

By bringing teams into the training program to learn as teams, we can also equip them to apply their learning as teams. But more important, by targeting the training for people who work together, we obviate the need to translate learning into the work environment. **The work environment is already present with the teams in the training environment.**

Results of the Seminar

The seminar has focused on producing concrete and measurable improvement projects. Although a number of general results like improved networking, improved awareness of TQM method, etc. have been achieved, only examples of specific improvement projects will be reported here.

Team improvement projects tend to fall into the following categories:

- Customer (internal or external) satisfaction;
- Quality of product or service;

- Work process/procedure;

- Supplier (internal or external) performance; and/or

- Team Development.

We have collected data on over 300 projects undertaken by teams. The following section of this paper will show the results that EG&G Florida, Inc. has achieved through the seminar. Examples of the projects of teams from the other organizations include such achievements as:

- Establishment of new procedures for centralizing data, documents, etc. for all groups involved with hazardous gas.

- Changes to eliminate incidents of damage to test fixtures and equipment of Launch Equipment Test Facility.

- Development and delivery of training in test tools that contributed to reduction in LPS down-time. Since 1989, down-time has been reduced from 4% of support time to less than 0.1% of support time.

- Development of "User Services Comment Card" to inform end-user comments on services. Initiated the development of software to track all computer all computer related trouble tickets, customer service requests and PC/Network configurations. The system now saves approximately 100 work-hours per week.

- Development of procedure with goal of zero defects in printed circuit boards. Results in 1991 were great reduction in production time and error rate.

- Improvement of problem report flow during solid rocket motor/external tank processing.

- Development of discrepancy documentation logbook system to reduce process time and work hours used by quality, engineering, and configuration management in determining validity and/or prior acceptability of an observed discrepancy.

- Designed new travel request process and significantly reduced time, people, and paper involved.

How EG&G Florida Has Made Use of KSC's TQM Seminar

EG&G Florida has found that the key to building motivated teams is to give them quality training to function as teams. Teams are motivated when they feel they are

functioning efficiently and experiencing success as a team. We have a variety of TQM training programs for teams and KSC's TQM Seminar has been an integral part of this training. The seminar has been effective in both equipping our own EG&G teams as well as integrated teams composed of EG&G members and members from NASA and other KSC contractors.

Examples of Integrated Teams

Selected examples of KSC integrated teams and their results are described below.

Heating, Ventilation, and Air Conditioning (HVAC) Teams - The design, development, procurement, installation and maintenance of HVAC controls is a very complex operation that involves NASA, the Base Operations Contract, the Shuttle Processing Contract, and the Payload Ground Operations Contract. The issues involved in the HVAC controls function present many opportunities for improvement that can only be addressed cooperatively by key personnel from all the organizations involved.

A special seminar was held on April 7-8, 1992 to address the problems surrounding HVAC controls. Represented at the seminar were NASA directorates: Design Engineering, Center Support Operations, Shuttle Management and Operations, and Payload Management and Operations, and the three major contractors at KSC: EG&G Florida, Lockheed, and McDonnell Douglas. As a result of this seminar, the following teams were formed to pursue the improvement in the process of HVAC controls.

- **HVAC Design Team** is improving design documentation, assuring operational requirements are met, assuring life cycle costs rather than one time costs are utilized in project analyses, and developing HVAC controls strategy which utilizes the recommendations developed by the O&M team.

- **HVAC Operations and Maintenance Team** is improving the operability and maintainability of HVAC controls, assessing current methods of specifying O&M requirements, and measuring improvement initiatives.

- **HVAC Integrated Team** is integrating HVAC training requirements for O&M technicians and engineers, design engineers, procurement, and construction management personnel.

Propellant and Life Support Teams - Many issues surrounding KSC's propellant and life support requirements provided similar opportunities for improvement. As a result, a special seminar was recently conducted for NASA and contractor personnel involved in propellant and life support processes. The following teams were formed to pursue continuous improvement in propellants and life support processes.

- **Facilities and Systems Design Team** is improving the process of designing, constructing and activating propellants and life support projects, especially those involving two or more engineering disciplines, operations, contracts, and

those involving two or more engineering disciplines, operations, contracts, and construction management.

- **Environmental Regulation Team** is improving the process of compliance with environmental issues, e.g. industrial waste water, hazardous waste handling, etc., to ensure unified action planning, timely distribution of information concerning changes in environmental compliance, and improved evaluations of the impacts on affected organization.

- **Fleet Sizing Team** is streamlining the planning and documentation process for "right sizing" KSC's propellant and life support mobile equipment and facility systems.

- **Resource Scheduling Team** is eliminating duplication of effort and improving the process of allocating and scheduling propellant and life support to achieve more benefit from scarce and valuable human resources.

- **Shared NASA/Air Force Resources Team** is examining propellant and life support requirements in support of NASA and Air Force customers and resolving the funding issues that will provide for the sharing of manpower, equipment and facilities.

Energy Conservation Team - During the last two years, the NASA and EG&G Energy Conservation Team have made significant strides in reducing energy consumption at KSC which has resulted in well over a million dollars per year in annual energy savings. The team developed programs for installing new meters to measure energy consumption, installing timers to reduce energy consumption at facilities during unoccupied periods, investigating and targeting projects to improve energy efficiency in selected facilities, and lobbying for improved energy conservation methods through the design review process.

Configuration Management Team - The primary goal of the NASA and EG&G Configuration Team was to improve the quality of the configuration management process to ensure that all necessary controls and procedures were in place for adequate configuration and control of KSC critical and configured systems and equipment. The team's initial project involved an end-to-end analysis of the processing of our system work authorization packages to understand how each process was accomplished. The project resulted in 49 specific improvement initiatives which has resulted in a systematic approach for identifying, controlling, and accounting for all configuration changes to KSC's critical and configured systems that are the responsibility of NASA Center Support Operations and the Base Operations Contract.

"Property Pushers" Team - After showing an upward trend in the number of lost or misplaced items of government property, our Property Management organization, along with NASA and other KSC contractors, recently participated in a center-wide

effort to educate space center employees of their responsibilities in the proper use, case and protection of government property. The integrated team used total quality management tools and concepts to determine why property is lost and identify solutions. Based on the team's request, Center Director Robert Crippen designated the week of July 5-11, 1992, as KSC Property Awareness Week which effectively heightened awareness of the individual responsibility of civil service and contractor employees to protect property from loss or damage.

KSC Wellness Network - The KSC Wellness Network involves NASA, EG&G, and other KSC contractors. The team is achieving significant progress in promoting well at KSC. Current projects of the team include planning for National Employee Fitness Day, planning for KSC Smoking Cessation Program, and expanding our Weight Watcher Programs.

Payload Customer Badging Team - The security requirements of customers involved in payload experiments presents many opportunities to improve the way we do business with this set of customers who are generally unfamiliar with KSC and our security requirements. The objective of the Payload Customer Badging Team is to provide education to payload customers pertaining to paperwork required for badging, improving communications with the Air Force and other organizations involved in the badging process, and providing policies and procedures that will ensure payload customers are badged in a timely manner.

Examples of EG&G Teams

The KSC TQM Seminar has been a major catalyst in motivating EG&G teams to improve the quality of the services they provide to their customers. During the term of the seminar, teams from seventy-eight different functional areas have attended the seminar. The following teams provide selected examples of improvement projects and results of the EG&G teams:

Master Planning Team improved the Centerwide drawing scanner system and developed a common data base to be shared by all users at KSC.

Water and Waste Team improved planning process that effectively reduced bench stock re-work and decreased real time logistics support to procure parts.

Resource Protection and Planning Team installed project boards to communicate current status of all projects, developed common format for regular and limited surveys, developed process to share design review information on all projects to everyone involved in the resource protection and planning process.

Metal Shop significantly reduced time to complete Work Authorization Package.

Logistics Analysis Team developed baselines for services provided, initiated customer surveys to determine the areas in which the team should strive to improve, and

developed a set of quality performance indicators to track the team's performance.

Propellants and Life Support Design Team developed "how-to" handbook for engineering assessments.

Launch Readiness Assessment Team generated a user's handbook of launch readiness assessment procedures and subsequently trained all users in these procedures.

Fix-It Crew reduced cost of purchasing new valve assemblies for rechargers, reduced turnaround time for maintenance of rechargers from three days to one day, and initiated a project to reduce maintenance time for compressors.

Financial and Administration Support Team developed and placed on line a user's guide for the NASA Stars Financial Application process.

Computer Operations Team implemented a monthly save process for all test and production databases which resulted in savings of 110 tape cartridges and eliminated the handling that was previously required to transport save tapes to a disaster recovery library.

Lessons Learned

Kennedy Space Center's Total Quality Management Seminar's impact on team development has been very significant. The teams that have been trained in the seminar have had to overcome various obstacles and have had to struggle at times even to survive. As we reflect on this activity, we can identify a number of mistakes we made, opportunities we missed, and a few things we would repeat if we had the opportunity to do it all over again. The following lessons learned were developed based on the perspective of the teams and others closely involved with KSC team activity. The lessons learned may help others who want to undertake similar integrated team-centered improvement initiatives.

1. **Senior Management Communications** - We could have done a better job keeping senior management and other key players more fully informed of the progress of the seminar and its results. The result of not accomplishing this task resulted in some organizations not taking full advantage of the seminar and a lack of clear understanding in some organizations of how the seminar could fit into their overall total quality management plan and initiatives.

2. **Facilitators** - Using trained facilitators in this seminar has proven to critical to its success. The time that it takes to teach facilitators how to help a group function effectively as a team takes time and the time factor is usually underestimated. We have learned that skilled facilitators become a real resource to the organization and in many cases can make or break the success of the teams. We should have done a better job with our facilitators.

3. **Organizational Development** - We have learned that training can be more than imparting knowledge; it can be an organizational development strategy. An organization's strategy for TQM integration must provide the necessary education and training to enable teams to function effectively in a total quality environment.

4. **Team Arrogance and Dissidence** - We have found that it is sometimes necessary to overcome the arrogance of team members who assume that, "We're already a team and we don't need training." Training helps clarify how the team will work together, what tools the team will use, how they will make decisions, what goals they will pursue, how they will share the workload, etc. We have simply underestimated at times the energy it takes to develop a team.

5. **Structured Feedback Process** - There is immense value in using a structured feedback process in team training. The feedback process provides the teams a clear perspective of where they stand relative to a set of characteristics that are known to be associated with superior teams. The survey tool used for the team's feedback has been very effective in re-surveying the team at some point in time after the seminar to evaluate if the team is improving relative to the set of superior team characteristics.

6. **Team Centered Training** - We believe strongly that training should be conducted in a team format. Teams should be trained as teams and provided with skills and tools that can be immediately applied in their own work environment. It is highly efficient to train the people **together** who must work **together**.

Summary

Teaming within EG&G Florida and teaming with NASA and our fellow contractors at KSC for continuous improvement are primary objectives in EG&G Florida's TQM initiative. KSC's TQM Seminar has contributed to this objective and has yielded such benefits to EG&G Florida as: team development, improved work processes, improved customer satisfaction, and improved quality of work life for our employees. Our integrated teams are providing win-win-win situations for NASA-Contractors-Customers; it is through the integrated team activity that we actually translate the need for closer integration and cooperation among all organizations into specific initiatives that results in overall improvement in how we conduct our business at KSC.

Conclusion

KSC's TQM Seminar has made a significant and quite special contribution to the TQM initiatives of NASA and its contractors at KSC. The seminar has produced a host of specific improvement initiatives and has led to the organizing of many integrated teams that can truly represent a joint NASA-Contractor TQM initiative. But perhaps the most lasting contribution that the seminar has made is that it has established a precedent for joint NASA and contractor TQM training and it has proven that such training works.

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D5 Successful Stories for Implementing System Level TQM/CI Tools (Continued)

This panel provides a follow-up to Panel D. Additional case studies demonstrating practical applications and specialized techniques are presented.

William R. Kearney, Quality Advisor, Bechtel Corporation, **"Process Flowcharting - Down and Across."**

John W. Griffin, Jr., Manager, Orbiter's Communication and Tracking Systems, **R. Matthew Ondler**, Aerospace Engineer, AND **Glen E. Van Zandt,** Human Resources Development Specialist, Lyndon B. Johnson Space Center, **"JSC Experiment in Taguchi."**

OMIT

Process Flowcharting - Down and Across

William R. Kearney, Quality Advisor, Bechtel Corporation

Introduction

We at Bechtel surely did not invent process flowcharting or continuous improvement. We copied our technique and added a few refinements just like about everyone else. At first, we packaged our methodology as a product. We had a shark mentality to purely reduce costs. Those horrible words 'efficiency expert' were even uttered occasionally. Thank goodness our motivations have changed since then. Deployment flowcharting can address only operating costs if that is adequate, but there are greater opportunities. It has been quite an education. Today, we know better than ever how we really do our work and how to make improvements occur in addition to reducing operating costs.

Any organization that starts flowcharting will have plenty of war stories in no time at all. Flowcharting can be fun or it can be hell. Yes, there is a choice. Working with numbers will trigger a yearning for 'good numbers'; as resistance arises, taking sides will subtly set in; and patience for results will be strained. There are temptations and it does require restraint. But it can be fun, too. The first rule is: deployment flowcharting is evolutionary: not revolutionary.

We found that flowcharting gave a voice to the people actually doing the work. They tuned into the approach to improvement by flowcharting and were highly motivated to make their voices heard through revised or eliminated procedures and they accepted an increased equity in the processes they participated in. They were constantly pestering and inquiring regarding implementing new methods. It was the people at the shop floor level who insisted that their managers and supervisors be trained in deployment flowcharting and process improvement strategies. They saw opportunity in using flowcharts, but also saw resistance to change in systems, that is some cases, were created and defended by their supervisors. Performance where expectations were predictable, but mediocre, were easy to manage and continue without challenge.

Process Flowcharting - Down and Across

This paper is intended to give insight to process flowcharting beyond being a TQM buzzword. Although a powerful tool, there are many tradeoffs to consider. Process flowcharting is quick to gather interest and perseverance will pay off. After 5 years' experience in a multi-corporate, multi-national environment, deployment flowcharting has proved to be a very positive force toward continuous improvement. The following aspects of deployment discussed are:

- **Why deployment flowcharting is used**
- **Benefits of flowcharting processes**
- **Preparation and training**
- **How this technique works**
- **Results**
- **Limitations, caveats, and lessons learned**

A list of suggestions for implementing deployment flowcharting in any organization is located at the conclusion of this paper for those who wish to further consider use of this tool.

Why Deployment Flowcharting is Used

❖ **It is tangible.**
Many people have a different perspective or image of a process. A flowchart provides a clear picture of what <u>really</u> happens. It can be displayed on a wall, is transportable, and can be used for historical reference purposes.

Process Flowcharting - Down and Across

- **It is familiar and easy to use.**
 Flowcharts are good visual tools that are easily shared and understood by people who have no flowchart training. They also show the magnitude of a process. Flowcharts (although not deployment style) are used in everyday instructions and in many areas of technical training.

- **It is a good fundamental tool.**
 A flowchart can be used as a source document for cause & effect diagrams, affinity diagrams and many process measurement tools.

- **It gets everybody in the process involved.**
 Many people want to 'see' what they do in flowchart form. Flowcharts highlight all the persons who participate in the process, who may each be a contributor in changing the process.

- **There is no in-depth training.**
 Flowcharting is offered as in-house 4-hour workshop. There are also abbreviated versions that are only 1.5 to 2.5 hours, depending on the audience, their desires, and of course, schedule.

- **It can be used now.**
 Endorsement and empowerment can be exercised at any level. Although maybe limited to intra-departmental processes to start; preparation and training time are minimal.

- **To further understand how we are organized.**
 Flowcharts added form to the work being done. There are processes that do not appear to have 'owners', so flowcharts can be used to identify where responsibilities lie.

- **A good tool for identifying process metrics.**
 Flowcharts highlight tasks and products that internal and external customers will judge. They invite "how many's", "why's" and "when's" that can easily be transformed to chart form for tracking critical process factors that customers may not be aware of - they may be getting a good product from a bad process.

Process Flowcharting - Down and Across

Benefits of Flowcharting Processes

- **Breaks the process down, facilitating improvement.**
 Flowcharting works to prevent over simplifying how services are delivered or products are built. Specific changes can not often be determined from general processes.

- **Provides a visual image of the process.**
 Many processes are too large and complex to analyze without converting them to written form. A flowchart eliminates varied interpretations of a process.

- **Gives opportunity to learn how the process really works.**
 Managers sometimes do not realize how many participants there are and have a tendency to see the process as it should work instead of how it really works. Flowcharts highlight what happens, who does it, and when there is rework and errors. Flowcharts also serve as a good 'road map' for training and indoctrination of new staff.

- **Highlights obvious duplication of effort and other inefficiencies.**
 Upon seeing a flowchart for the first time, frequently the first comment is "Do we really do this?" Inefficiencies abound and leap out of the flowchart. Eliminate them now.

- **Clearly identifies all customers and suppliers.**
 There are hidden customers who are revealed by constructing a flowchart. Flowcharts show the level of participation of all involved and what they bring to the party. Identifying customers and suppliers reveals who performs the key roles and their potential impact on the expected time to complete a process.

- **Provides a basis for process metrics.**
 Flowcharts establish a baseline for process improvement. The 'old process' becomes a reference for comparative purposes. Key tasks and deliverables (and also errors) could be identified, then counted or categorized for further process improvement efforts. Flowcharts have been very helpful in developing Pareto charts, histograms, and control charts.

Process Flowcharting - Down and Across

❖ **Serves as a comparative benchmarking tool.**
Flowcharts invite high participation by the people doing the work. They will often start comparing notes informally with their counterparts. Formal metrics development highlight the relative performance of a process performed in different locations. Flowcharts invite sharing and networking among co-workers to take advantage of the best techniques and technology available.

Preparation and Training

❖ **There are 4 types of internal process improvement support:**

- **Specific studies - Perform all analysis, research and flowchart development.**
- **Team leader - Spearhead processes being studied by improvement teams.**
- **Coach/Facilitator - Assist in techniques and facilitate meetings.**
- **Training - Process measurement, introduction to continuous improvement, deployment flowcharting techniques, and team building.**

❖ **Conduct Deployment flowcharting workshops.**
Endorsement by management and their ability to allocate time to execute upon the training afterward are critical to the success of process improvement. Sometimes, training is focused on teams, and at other times, general departmental or multi-departmental workshops are held. A modularized workshop ranging from 1.5 to 4.5 hours is given to teams or organizations about to embark on a focused process improvement effort. The workshops are always prefaced by a senior manager or company officer who frequently attends the entire workshop.

❖ **Management commitment is paramount.**
They must be patient to see results. They must be open to change and a hiccup or two in making things better. They must be forgiving of those who believed they were contributing to the process and perhaps were not.

Process Flowcharting - Down and Across

❖ **Select a process.**
Avoid large processes to start or define a scope to limit the extent of a process to be studied. Divide work into finite functions. Use a tiered approach if necessary; use an Input / Process / Output diagram or high level flowchart to start. Foster teamwork to prioritize processes to study further.

❖ **Begin using flowcharting software.**
Select a package that is easy to learn and easy to make revisions. It is preferable to use software capable of operating under a network environment. Also, ensure chart printing can be easily accommodated. MetaDesign, MacFlow, MacDraw and EasyFlow are some of the examples of good flowcharting software.

❖ ***Make change the order of the day.***
Process improvements are often the result of collaboration and some salesmanship. Networking with other organizations fosters communication that leads to change. Time must be allocated to draft an initial flowchart through interviews and to generate an electronic version which can be revised and enhanced in a 'process to be' form. Time must also be set aside for 'what if?' thinking. Everyone should challenge if the current way to do things is really the best way as they go about their everyday business.

How This Technique Works

❖ **Getting from broad systems to specific processes.**
Determining where to start deployment flowcharting in organizations that are complex, perform many varied functions and appear 'hurried' is not an easy task. It can be done by a 'Divide and Conquer' technique. We will assume at this point that either a team or our participants have been trained in flowcharting techniques.

- **Ask "What does this organization do?", "What are its products?"**
- **Develop a list of major functions or products**
- **Diagram an Input/Process/Output Chart to:**
 - **Get a better visualization of the process.**
 - **Develop processes into entities than can be drawn.**

Process Flowcharting - Down and Across

- **Select a process or product that can be expanded into a deployment flowchart.**
 - **Use a high level flowchart and then progress to a more detailed flowchart if necessary.**

- **Use the 'Flowcharting Path' diagram as a guide.**

Although deployment flowcharts are familiar to us all, to summarize the deployment flowchart (see example which follows):

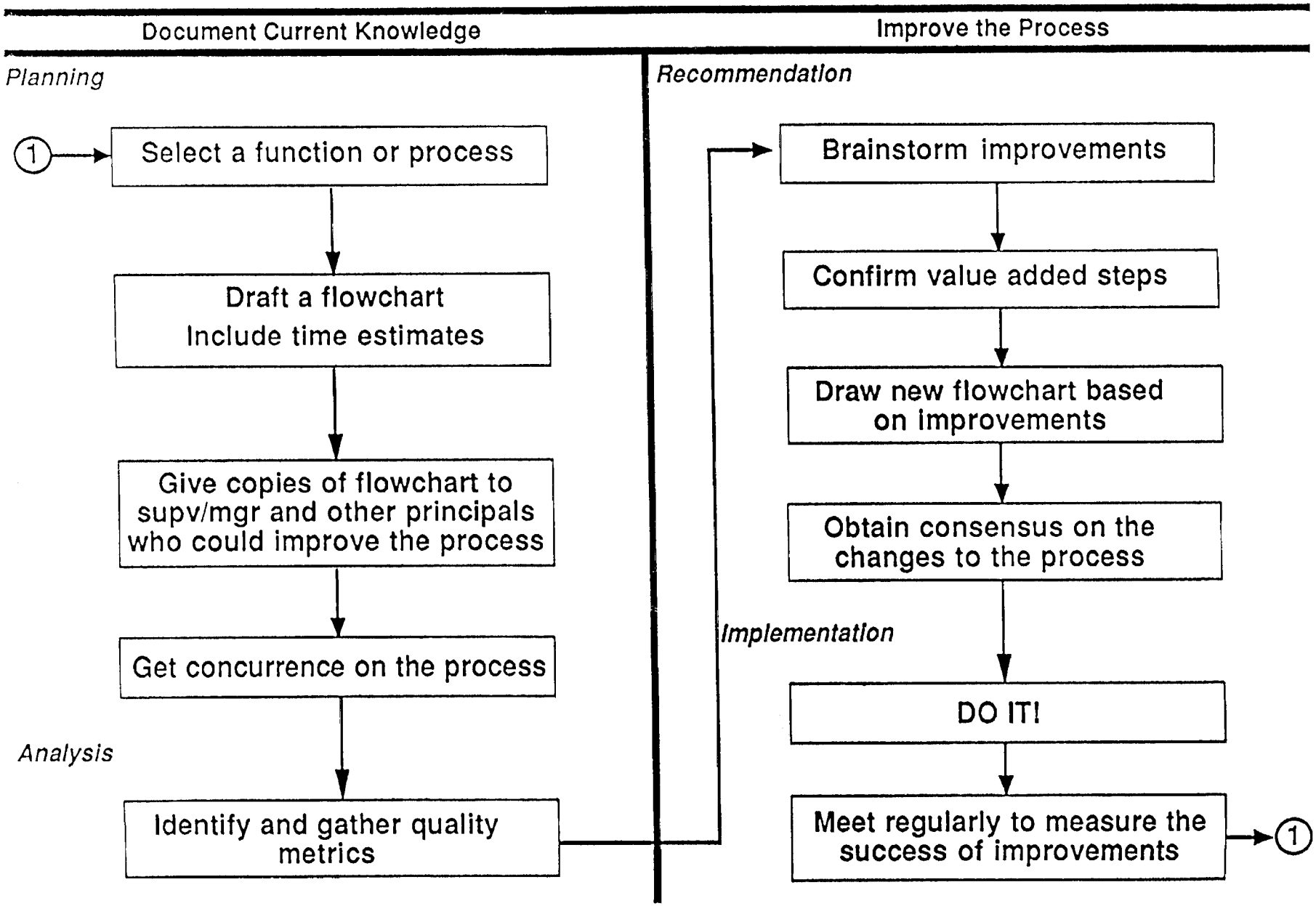
1. *The path is generally down and to the right.*

2. *The participants in the process are given reserved rows or columns depending if the flow is being drawn vertically or horizontally.*

3. *There are very few symbols used. They are:*
 - *Process (box)*
 - *Comments (half box)*
 - *Decision (diamond)*
 - *Connector (circle)*
 - *Related processes (box within a box)*
 - *Connector lines with arrows*

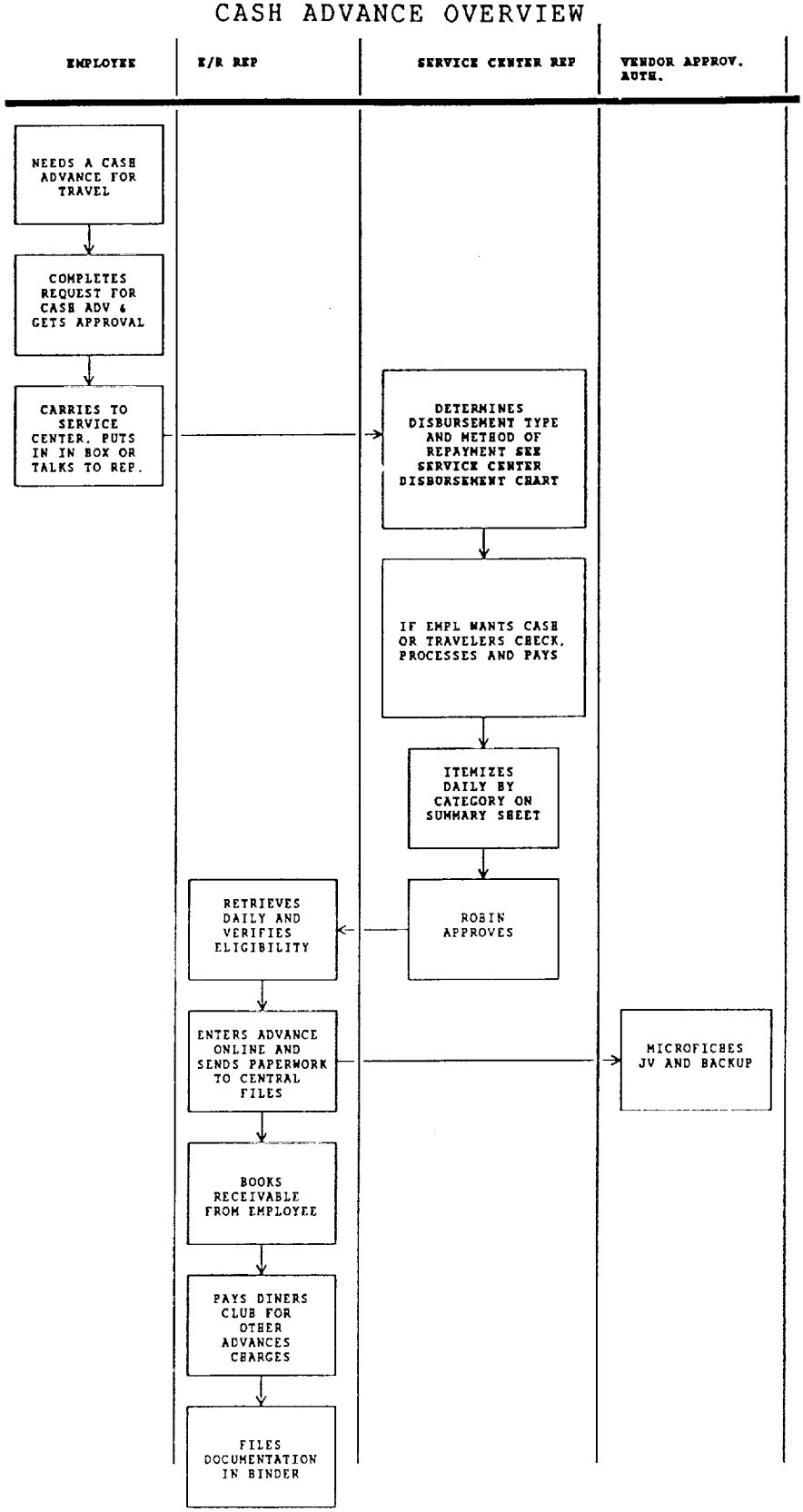
A walkthrough of a flowchart of the existing process serves to:
- *Confirm the process as drawn*
- *Identify measurements and process metrics*
- *Challenge the value added elements of tasks performed*
- *Look for improvement opportunities*
- *Document proposed changes*
- *Rethink assumptions and constraints that apply to the process*
- *Generate a proposed process and action plan for improvements that can be implemented within the short term and long term.*

Flowcharting Path



1M72/7/PS

CASH ADVANCE OVERVIEW



Process Flowcharting - Down and Across

Results

- **Virtually all accounting operations have been flowcharted within Bechtel.**
 Some resisted, but most clamored to get started. Many inefficiencies were eliminated and improvements were slowly, but steadily implemented.

- **Flowcharts were used as an engineering systems development tool.**
 Our best minds use flowcharting to get back to basics to more easily see how work is done when imagining future generation engineering tools.

- **Today's comprehensive metrics began with flowcharts.**
 Today, we conduct a monthly video conference to share process metrics among our 5 major US offices and London office. Typically, there are 50 individual presenters who report on standard metrics, all within 2 hours. The video conference is always chaired by our Chief Financial Officer. Senior managers' attendance are required. Flowcharting processes to identify metrics and flowchart sharing continue to have an important role in our on-going continuous improvement efforts.

- **Flowcharts were a key factor in new partnerships:**

 - **Payroll and Personnel**

 - **Procurement and Accounts Payable**

 Today, video conferences among functional groups are common. This effort was inspired by the monthly metrics video conference that initially forced communications on similar processes between geographical locations.

- **Increased pride and equity by the people doing the work.**
 What is a better feeling than seeing your recommendation implemented and things are working more smoothly? Successes nurture other successes, like the chain reaction that W. Edwards Deming professes. This is also an opportunity to become planners versus being bogged down in reaction mode. People within the process developed a compassion for others when they more fully understood the entire process.

Process Flowcharting - Down and Across

Limitations, Caveats and Lessons Learned

Depending on how long particular tasks in a process have been in place and the motivation for change (especially by leadership), it is often too easy to go back to the old routine after a process improvement has been initially adopted. Also, any hitch becomes a reason to fall back to the original way to do things. People are quick to recoil and give up new methods even if the potential payoff dividends are large. Participants in a process are embarrassed and offended when they are honest about process steps or knowledge of a process which may inhibit it from performing optimally. Worse yet, managers and supervisors often reprimand workers who are merely victims of the system.

- **Flowcharting will do more refining than overhauling.**
 Generally, the process stays the same although improvements can range from minor to vast. It is rare to see total process elimination or major restructuring within a short term. Generally, changes will be evolutionary, not revolutionary.

- **A cost reduction theme can overshadow process improvement.**
 Becoming too budget conscious leads to pursuing only the 'big ticket items' and an incremental view of processes. It is difficult to place specific time intervals on tasks coupled with other tasks. Even then, estimates could be good or bad. Getting caught up in the numbers can be a deadly trap and will offer nothing but dispute.

- **Barriers are everywhere.**

 - **People easily revert to old habits.**
 - **The new process lasts only until the first mistake.**
 - **Some people fear being punished if the system is already flawed.**
 - **Mistakes and past behaviors must be forgiven.**

Process Flowcharting - Down and Across

- **Avoid changing for the sake of change. Transferring work is not an improvement.**
 Making 'them' do it isn't the answer. There is a tendency to look good by transferring work or responsibilities to another department. Sometimes it is warranted but must be agreed upon. Other times, without fully coordinating all the efforts in a process, tasks can be arbitrarily shifted unjustly.

- **There is reluctance to innovate and take risks.**
 There are people that won't change, period. Some good improvements will never be implemented due to the fear of failure. Assumptions are difficult to overcome when trying to inject new fire into the old routines. Not a bad place for implementing Lee Iaccoca's motto of 'Lead, follow, or get out of the way'. The message from our CFO has been 'Catch the spirit or catch the bus'.

Suggestions for Implementing Deployment Flowcharting in Your Organization

- **Train the people doing the work.**
- **Do not start with a process too large.**
- **Advertise successes.**
- **Attack the opportunities for small improvements with the same energy as large improvements.**
- **Allow people to be honest about flaws in the system.**
- **Don't think in terms of costs.**
- **Make it clear that no one's job is at stake.**
- **Get partners to help improve the process.**
- **Be patient (but not too patient).**

Process Flowcharting - Down and Across

Suggestions (cont'd).

- **Drag out those old suggestions.**
- **Make a commitment to follow through.**
- **Do Something. Implement your findings promptly.**
- **Get commitment at all levels. There are frequently 2 types of managers:**
 - **Those who welcome help in improving and changing.**
 - **Those who are defenders of systems they created.**
- **Buy a good flowcharting tool.**

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JSC Experiment In Taguchi

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HOW JSC GOT INVOLVED IN TAGUCHI

A flood of TQM activities inundated JSC about a year and a half to two years ago. A new language with words and phrases like, Quality Culture, Values, Mission, Goals, Customer Focus, Continuous Improvement, Concurrent Engineering and Problem Solving Tools started to appear in everyday conversation with upper management. The virus of TQM started to infect JSC. Management started to understand that a new way of doing business was needed to cope with a very full plate of commitments. An advanced tool, the Taguchi Method, was mentioned in introductory TQM training, but not explored as being beyond the scope of the discussion. Max Engert, Deputy Director of Engineering at JSC, believed that this tool could be a valuable asset to the engineering community. He encouraged the engineering folks to become proficient in the application of this method and make it part of our every day business. A number of our engineers were aware of the basic concepts through readings and other sources. As they tried to get some applications going, it became apparent that formal training would be needed to properly set up the experiments and get good data.

WHAT PROBLEMS WERE ENCOUNTERED DURING TRAINING

We held our first course in December 1990 which was a 5-day session on quality engineering using Taguchi Methods. Our first lesson-learned came from this session. We made the mistake of putting engineering managers through the course rather than their working troops who would be doing the applications. Course examples were manufacturing in nature, hence most people had a hard time relating examples to their area of interest. It certainly raised the participants' awareness of the techniques and their usefulness, but 5-days was too long and too detailed for their needs. For managers who will not be digging into the applications, a short discussion of the Taguchi philosophy and mechanics of the experiment is probably enough.

Following this session, we presented a number of courses for our engineering staff. Some were taught by consultants who came on-site and others were taught via satellite on the National Technological University (NTU) network. These courses and the early applications provided a few more lessons learned on the training process.

LESSONS LEARNED FROM THE TRAINING PROCESS USED AT JSC

The first lesson learned concerns outside training consultants. There are a large number of them out there who will provide in-house training for organizations. There are certainly some that are good and some that are not; however, each comes with their own particular biases and experience base in terms of applications they have worked with and seen. Beware of those who tout Taguchi as "the" solution or glamorize it too heavily. If you can find a local source, it is usually a good choice. Short courses of 3-5 day's duration are inherently difficult in terms of the amount of material presented and the amount retained, and it seems worse with this subject matter. The ability to spread the course out over a few weeks and to provide follow-up consulting is very useful. That way people get a chance to go back to the office or lab and think through their own applications. Many times this will raise questions they can go back and ask at the next class session.

Once you have decided who is going to conduct the class, the next issue is what to emphasize in the presentation. Two objectives stand out -- 1) the need to teach the technique of how to select a problem where Taguchi will be appropriate, and to set up the experiment; and 2) the need to teach the mathematics of the arrays and associated calculations. We initially focused on the latter, but found this is relatively easy for most engineers. Choosing the problem and setting it up appears to be the most important element for inexperienced practitioners. The participants do not need an extensive statistics background to be able to understand and manipulate the arrays. There are several PC-based packages out there which will do the calculations for you, quickly and easily. It may be useful to discuss one or more of these within a course. Some exposure to Analysis of Variance (ANOVA) and Latin Squares would be helpful in understanding the underlying fundamentals of Taguchi. If the course combines design of experiments (DOE) with the Taguchi Method, then a basic knowledge of statistics becomes more important. Most instructors won't review these concepts, assuming the participants are already familiar with them.

Another issue the instructor may face is a certain amount of skepticism among the participants about the usefulness of Taguchi Methods and the application "to our problems and situation." The worst response to this is to hype the techniques and try to do a sales job on them -- this will throw up a barrier that can doom the rest of the session to failure. Most of the class participants will be technical people who need to evaluate the effectiveness and possible uses for Taguchi Methods. The best

selling point will be discussing real applications, how those problems were selected, and how the experiment was set up. The most successful courses we have held focused on working the participants' own applications within the class. This approach gives them a head start in transferring what they've learned back to their own job.

Another important lesson is that no single course will make one highly proficient in using Taguchi. It takes time and practice to build the experience base and to become comfortable with the application of the Method. It is also important to recognize that Taguchi is not the only tool that should be in your quality engineering tool kit. Classical design of experiments (DOE) methods are also very useful depending upon the problem. We have adopted the approach of teaching DOE along with Taguchi to expose our engineers to both tools. This helps clear up some of the confusion around which tool is appropriate and in what applications. In addition to this, we provide training for other quality tools such as quality function deployment, and concurrent engineering.

WHAT IS JSC'S DEGREE OF INVOLVEMENT

The Engineering Directorate has chosen to follow the path of training the trainer. Two types of education are needed. One is the education that allows one to apply the Taguchi Method. Here the focus is on setting up the problem, turning the crank and understanding the results. The other type of education needed is to identify when the Taguchi Method might be applicable to a problem. We have found that not all problems are Taguchi problems. During a meeting of our first trainees, almost to the person, it was agreed that we have a solution, but we can not find the problem.

JSC'S FIRST SET OF PROBLEMS WHERE TAGUCHI WAS TRIED

A number of problems were initially analyzed using Taguchi Methods. These problems were diverse and cut across many engineering disciplines at JSC. Because this was a new technique the engineers encountered many problems. The following section will give a brief description of the problems Taguchi Methods were applied to as well as provide lessons learned.

PROBLEM DESCRIPTIONS

Low Thrust Mars Transfer Abort Study - Develop a method of predicting Nuclear Electric Propulsion vehicle abort performance after the partial loss of thrust and/or power by using Taguchi Methods to predict the performance response over a wide design space.

Maximize Low Energy Trans-Atlantic Landing (TAL Abort) Performance for the Space Shuttle - Determine the optimal values of Main Engine Cut-off low energy guidance targets to maximize the probability of reaching a TAL landing site in situations involving two main engine failures.

Voice Command System - Determine the optimum parameter settings of the Scott's Instruments recognizer.

Space Station Antenna Study -- optimize antenna location for communication coverage.

Solid Amine Absorption Capacity Test - Determine the capacity of the new absorbent under various operation conditions.

Main Propellant System 750 psig Regulator - Determine regulator assembly parameters that most effect regulator stability using computer simulations and then test verification.

N2O4 Catalytic Decomposition Study - Determine important parameters in the decomposition of N2O4

Reaction Control System (RCS) Thruster Low Frequency "Chug" Stability Parameter - Determine important parameters that effect the low frequency stability of the PRCS thruster using a computer analysis.

LESSONS LEARNED

A survey was developed and sent to all of the initial users of the Taguchi Method. The survey indicated that the average respondent had just under 40 hours of formal Taguchi training. Also, the respondents thought the Method produced results better than the results obtained from traditional methods. Almost all of the respondents stated that they would use the Method again. Most users felt that the Taguchi technique was not a cure-all, but a tool that was powerful in specific applications. A few select answers from the survey are provided.

Question: What were, if any, the savings in the cost, time, computer runs, etc., you experienced using the Taguchi Methods?

"No time was saved, due to the time required to understand the Taguchi Method. What was provided was a structured way to perform the tests."

"The time savings for this first try was minimal, but once the procedures are in place I could re-run tests very easily and investigate some other parts of the problem. I suspect that the next project I apply this to, Taguchi Methods will be a great benefit"

"By using Taguchi Methods to design the experiment, we were able to reduce the test points from 81 to 9. Thus we have saved about four weeks of test time."

"None. Although handover time was a control factor, it was a parameter which we used in post-processing of simulations so it did not save any simulation runs"

Question: What were the lessons learned?

"Understand the technique before setting up Taguchi experiments so that you get meaningful results"

"DOE is useful for the study of design parameters"

"I started with an L9 and found that the interactions confounded the results. This stressed the need to do some precursor studies to determine how many runs are required"

"I tried to interface with an expert in statistical methods, and the fact that I didn't know Taguchi and that he didn't understand the voice recognition process resulted in an unsuccessful experiment."

Question: What would you suggest to someone using these techniques for the first time?

"Understand the technique before setting up Taguchi experiments so that you get meaningful results"

"Use a DOE computer program to assist in data reduction. Take an introduction course. Talk to those persons who have used it."

"Use it for a simple, linear system first. Then extend its application to a more complicated, non-linear system."

"To understand the Method fully before trying to set-up the experiment"

"The key to success is to realize that this is just a tool to do your job. You need to practice a few times to get confident with the Method. Brainstorm your problem and its parameters before you start so that you measure the correct metric."

WHAT ARE JSC'S PLANS IN THE FUTURE

We expect to see more application of Taguchi Methods as our engineers become better versed in it. To expose more of our technical staff to Taguchi, in the near future, we will continue to use outside consultants. Over time, we plan to develop our own people to serve as both trainers and "consultants" to provide guidance to other engineers applying the tools- both DOE and Taguchi.

A tenet of TQM is continuous improvement or doing things a bit smarter or a bit better. Taguchi is one tool that can help us do that. We will continue to be open to other tools to help us improve our engineering processes.

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D6 Establishing an Environment for Continuous Improvement at NASA

This panel provides two case studies of NASA TQM implementation - one from the John C. Stennis Space Center and one from a major program office at NASA Headquarters.

Dr. William F. Huseonica, Director, Science and Technology Laboratory, AND **Dr. Marco J. Giardino**, Center Education and Productivity Officer, John C. Stennis Space Center, **"Here's the Beef: A Case Study in Organizational Transformation."**

C. Shannon Roberts, Assistant to the Associate Administrator for Space Flight, **"Building a Quality Culture in the Office of Space Flight: Approaches, Lessons Learned, and Implications for the Future."**

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Here's the Beef: A Case Study in Organizational Transformation

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John C. Stennis Space Center

Dr. Marco J. Giardino, Center Education and Productivity Officer
John C. Stennis Space Center

Introduction

One, and we believe the primary goal, of understanding the Total Quality Management (TQM) process is to transform an organization toward customer focus, employee empowerment, and system thinking. This transformation process is on-going within the Science and Technology Laboratory at the Stennis Space Center. As with all change efforts, vision, leadership and proper implementation are essential ingredients for success.

The Challenge

The Science and Technology Lab (STL) is tasked with the design, development and application of science and engineering services. Formed in the early 1970s, STL adhered to many traditional attitudes including barriers to communication, excessive management control, parochial strategies, unclear measures of success, lack of customer focus, underutilization of people and excessive administrative burdens on scientists and engineers.

The challenge was to maximize customer satisfaction through the effective and efficient application of the notable skills and talents of the STL's workforce. In this way, the Lab would begin its exciting journey toward becoming world class.

Implementation

In early 1992, the Director of the STL determined to lead the Lab into the mainstream of the Stennis Space Center and prepare for the anticipated changes in roles and missions. The Director, assisted by the "internal process consultant", set about understanding TQM principles and techniques and identifying barriers to the new vision. He initially addressed the 10% of the barriers normally caused by people. All division chiefs were reassigned, and a process of removing the other 90% of performance barriers resulting from system problems was begun.

The Director's vision of developing a world class science and technology organization focused on meeting and exceeding customer needs and wants was communicated during all-hands meetings. A great deal of discussion was generated, especially around the role of management and the future of the earth science function, scheduled to be phased out as part of the new roles and missions.

Following the all-hands briefings, a list of existing and potential customers was compiled and distributed to all employees. All STL people were asked to prioritize which customers they most wanted to serve, based on personal interest and/or applicable skills and talents. Among the customers listed were the ASRM, NLS, and NASP project offices, the environmental office, the education office and the Commercial Programs offices among others.

After the lab personnel returned their choices, a series of meetings was held and everyone who had indicated interest in serving a specific customer was invited to the meeting. A customer representative opened the meeting by detailing existing and future requirements as well as measures of success. Following the presentation by each customer, Lab personnel was asked to reassess their desire to serve on specific customer teams. Through this self-selection process, core team members were identified as well as technical and administrative support members. A facilitator was assigned to each team. core team members were those who were assigned to each team. Core team members were those who were particularly dedicated to the customer in question and possessed the necessary skills to meet the customer's requirements.

At the same time, the middle managers began meeting as a team to redefine their role in this "new" organization. Also, the chiefs decided that as part of their role, they would identify those capabilities or services that were presently offered by the Lab and those that could be developed in the future both in response to anticipated customer needs and/or building on existing talents of the employees.

Clearly, not everything went smoothly. In the chiefs' meetings, a great deal of resistance and confusion surrounded the change effort. Several chiefs apparently were threatened by the proposed change and were very concerned about normal management issues. Among these, were issues of accountability and responsibility. Who proposed new projects? Who would make job assignments? Who would level manpower between tasks, assign resources, do performance appraisals, approve overtime, provide rewards, and set policy?

Each of these issues was addressed by the chiefs with the Director and his deputy during a full day "retreat". Several issues were resolved, and several more are being discussed a present. It was decided that the Director was still ultimately responsible and accountable for the performance of the Lab. Similarly, chiefs would
be responsible and accountable for the success of the customer teams. As assessed in large part by the team members themselves. The chiefs agreed to provide a new set of services to the teams including facilitation, coaching, counseling, and integration. Most importantly, the chiefs would be responsible for developing new capabilities, finding new customers, prioritizing which customers needed to be served by employee teams and which activities could be further developed by Advanced Planning functions (which remained within mid-management's control) in anticipation of future customer needs.

Further, the chiefs began to redefine their role as "boundary managers". For each team, one chief would serve as a mentor, with the expressed task of managing the interface between customer teams and the rest of the Center. Chiefs would serve teams in providing the proper equipment, facilities and resources, completing the administrative tasks required to procure these needed resources and facilitating the interaction between teams and staff offices

such as human resources, legal and procurement. The evaluation of their performance on these tasks would be completed in large part by the teams who were their customers.

Team members were responsible and accountable for customer interface, developing thorough lists of customer requirements with measures of success. Team members were also empowered to make changes, solve problems an implement decisions that they believed would improve their customers' satisfaction. Each team selected a leader. Leaders, it was decided by the teams, would be chosen among those members who visibly exhibited a passion for the process and would therefore champion it. Further, team leaders must be good communicators, prepare meeting agendas, provide direct customer interface and be responsible for reporting results. Team leaders also were required to be the single repository of all current customer requirements together with the ever-changing measures of success.

Results.

Many issues remain to be resolved. Team members often feel quite out on a limb and are still wrestling with how to utilize resources, add new work, and interact with their bosses. Chiefs wonder what level of involvement they can attain without appearing to over control their teams and still be assured that the job is being done and done right.

Yet, many benefits are already apparent after three months of working in the "new culture". Customers report that lab personnel is providing outstanding service and appear very pleased and motivated in their jobs. New products and services are being "bought" from the Lab by their internal customers as the latter become aware of the talents and skills being offered by the new teams. This level of talent was often invisible since managers did not always provide opportunities for employees to apply their skills to particular customers.

Reporting has been integrated and several redundant reporting activities eliminated saving time and money. Customers are pleased with knowing not only that there exists for each of them a single point of contact, but that Lab person is backed by a considerable number of skilled and dedicated people. The match between customer needs and Lab skills is better than ever. The clearly evident "customer focus" of the Lab has made it a viable and fully integrated part of the Stennis Space Center operation. Requirements are clear, visible and measurable. Capabilities are being enhanced, as employees are asked to spend 20% of their time away from customer teams and on improving their capabilities through research, development and interaction with universities.

Customer teams are active in ASRM, Commercial Programs, Economic Development, and Education. A recent conference sponsored by the Information Technology group utilized the concepts of customer focus to bring industry, academia and government scientists together with the many customers at Stennis to identify needs, explain processes and procedures to potential support suppliers, and begin matching capabilities to requirements.

Future plans call for more teams, a more defined role of Advanced Planning, particularly in the area of SEI (HLLV), NASP and NLS. We are constantly refining our methods of tracking the Lab's performance to customer requirements and are beginning to improve our systems to exceed our baselines, reach new benchmarks and thereby constantly move toward being a world class NASA laboratory.

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BUILDING A QUALITY CULTURE IN THE OFFICE OF SPACE FLIGHT:
Approach, Lessons Learned and Implications for the Future

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INTRODUCTION

The purpose of this paper is describe the approach and lessons learned by the Office of Space Flight (OSF), National Aeronautics and Space Administration (NASA), in its introduction of quality. In particular, the experience of OSF Headquarters is discussed as an example of an organization within NASA that is considering both the business and human elements of the change and the opportunities the quality focus presents to improve continuously. It is hoped that the insights shared will be of use to those embarking upon similar cultural changes. The paper is presented in the following parts:

- The Leadership Challenge
- Background
- Context of the Approach to Quality
- Initial Steps
- Current Initiatives
- Lessons Learned
- Implications for the Future

*The opinions presented are those of the author and do not necessarily represent those of the organization.

THE LEADERSHIP CHALLENGE

As we work towards maintaining or achieving world class excellence in multiple arenas, American public, academic and private sectors are faced with innumerable challenges, including the economy, jobs, the environment, education, health care, new technologies and international competition. To maintain or achieve world class status, particularly in a period of declining fiscal resources and competing interests, is a target of opportunity

for American government, academic and industry leaders to manage creatively and in partnership. In these changing times of: (1) working in a more global context; (2) increased customer expectations for quality, timely and efficient products and services; and, (3) reduced resources to work with, the opportunities for Americans to rethink approaches to business and culture are imminent. This refocus is particularly timely as we plan for the 21st Century and work to improve our leadership posture both nationally and internationally in all facets of life.

Proven successes abroad and in major American companies using the quality approach to change and continuous improvement have caused those of us in the Federal government to take note. The quality approach to business and cultural change is perceived by Federal managers as one which may help them: reduce the traditional bureaucratic barriers of overregulation; streamline procedures and operations; improve communications; optimize the use of human resources; and, reduce unnecessary layering and duplication. Agencies such as NASA have embarked upon a Federal quality tradition which emphasizes top management leadership and support, strategic planning, focus on the customer and the supplier, employee empowerment and involvement, employee development and recognition, measurement, and results.

While NASA has evidenced its external value for quality during the past decade with its George Low Excellence Award for the aerospace and related industries, the agency's internal corporate quality focus has been most notable during recent years under Administrators Richard Truly and Daniel Goldin. NASA centers, such as Johnson Space Center, Lewis Research Center, and Marshall Space Flight Center, have led the way for the agency in quality and have been recognized externally by the Federal Quality Institute and the President's Council on Management Improvement for exemplary Federal initiatives.

NASA headquarters organizations have followed the NASA centers during the past two years and have undertaken numerous quality initiatives from a corporate or headquarters-specific perspective. Consistent with quality's emphasis on "lessons learned" and "benchmarking" others, the following description is presented of how one NASA headquarters organization, the Office of Space Flight, has pursued quality. Discussed are the background, the steps taken, the lessons learned, and implications for the future.

BACKGROUND

The Office of Space Flight (OSF) is one of five NASA program offices. It is responsible for providing executive leadership, overall direction, and effective accomplishment of NASA space flight operations and utilization programs concerned with the Space Shuttle, Spacelab/Space Station Freedom, and other space flight operations. In cooperation with other NASA organizations and suppliers, OSF space transportation capabilities have made possible discoveries about the universe and Earth, material and life sciences, and the application of new technologies.

Customers. OSF supports a wide range of customers, including public and private sector interests and foreign governments. Foremost among the customers of the civil space program is the American public, to whom OSF is committed to bringing the highest quality effort in the most cost-effective manner. In addition, OSF carries out the objectives and goals established by the NASA Administrator in support of the direction set by the President and Congress. Other customers include the NASA program and functional offices, government agencies, foreign governments, commercial industry, colleges and universities, and elementary and secondary schools.

The Organization. OSF consists of an executive Headquarters office in Washington, D.C., and four field centers: the Lyndon B. Johnson Space Center in Houston, Texas; the John F. Kennedy Space Center in Brevard County, Florida; the George C. Marshall Space Flight Center in Huntsville, Alabama; and, the John C. Stennis Space Center in southwestern Mississippi.

The Associate Administrator for Space Flight, who reports directly to the NASA Administrator, manages an extensive institutional and technical base. This encompasses four OSF centers and consists of an annual budget of approximately $4.8 Billion and more than 10,000 NASA civil servants supported by 30,000 contractor employees.

The OSF team represents the diverse range of disciplines needed to support the management of project development, operations, and implementation. Expertise is maintained in numerous fields, including engineering; administration, human resource, information resource, facilities, and resource management; meteorology; policy; and, systems analysis. OSF Headquarters provides executive business management and broad policy direction. It is responsible for resources management, program management, advanced planning, institutional management, space flight manifesting, strategic planning, and external representation.

This paper focuses primarily on the OSF Headquarters quality initiative, which was pursued in the context of the Five Phases of Quality Maturity and the President's Quality Award criteria. The timeframe involved is August 1990 - present.

THE CONCEPTUAL FRAMEWORK FOR THE OSF HEADQUARTERS APPROACH

In pursuing quality, OSF Headquarters leadership was influenced by initiatives undertaken by the OSF Centers (Kennedy, Johnson, Marshall, and Stennis), other Federal agencies, and leading aerospace and non-aerospace corporations. To provide a conceptual framework for its approach, OSF considered the *five phases of quality*, which were developed by the President's Council on Management Improvement and the Federal Quality Institute, to provide a developmental context for Federal agencies pursuing quality. Also considered were the *eight President's Quality Award criteria categories*,which also provide a framework for quality pursuit.

The **"Five Phases of Quality"** , which were developed by the President's Council on Management Improvement and the Federal Quality Institute to serve as guidance to agencies in determining where they are with respect to achieving "world class" status, are:

Phase 1: **Deciding Whether to Implement TQM.** In this phase, the organization's top executives are actively considering whether to embark upon a TQM effort. This phase may include only the steps necessary to become aware of what TQM includes and its benefits, such as attending an awareness seminar, attending a training or conference on quality, or personal and organizational research. It may be as short as a decision to do it after a brief introduction, to as long as several months of gathering data and information upon which to base a formal decision.

Phase 2: **Getting Started.** A formal decision has been made to embark upon a TQM effort, and a formal announcement has been made to do so, either to key management staff or the entire organization. The Getting Started stage usually lasts about a year, and may consist of such activities as:

- Establishing a quality council or other body to direct the quality improvement effort;
- Developing quality vision, mission and policy statements;
- Assessing the organizations readiness and culture;
- Reviewing the organization's quality training needs;
- Developing an initial implementation plan including how to target and focus the quality effort and identification of training and other resources to carry the effort forward; and,
- Beginning some of the initial education and training of managers and/or line workers.

Phase 3: **Implementation.** During this phase, specific TQM-related processes designed to improve quality are being adopted. Such actions frequently include formal establishment of Process Action Teams or similar teams of workers to improve operations or eliminate systemic operating problems. Other actions might include identification of internal and external customers and determination of their needs and expectations; analysis of systems and processes in order to streamline operations and build in quality checks in the production process; and adoption of significant new policies designed to further quality management principles such as financial rewards and recognition for teamwork, formalized suggestion programs, adoption of group appraisal systems, and quality-related employee development efforts.

Phase 4: **Achieving Results.** After an organization has been in the implementation phase for a period of time, it should begin to achieve and document significant results flowing from the quality effort. During *Phase 3 - Implementation*, results will begin to occur as the result of individual team actions and Quality Council activity. During *Phase 4 - Achieving Results*, the organization will begin to realize systemic, cross-functional and/or organization-wide achievements resulting from the TQM effort. One individuation of having realized this stage may be if the organization has chosen to apply and is competitive for the Quality Improvement Prototype Award, President's Award for Quality, or similar recognition established by the organization's own agency.

Phase 5: **On the Way to World Class.** An organization that is on the way to World Class has generally incorporated all of the principles and operating practices of TQM throughout its organization in some degree, can point to substantial improvements in quality and customer satisfaction resulting from these efforts, and is making consistent and continuous improvement throughout. Such an organization

would normally be a strong contender, if not actually a winner of the President's Quality Award, and would be compared favorably from a quality standpoint with any other organization in a similar line of work anywhere else in the world, public, or private.

The **President's Quality Award Criteria,** which are modeled after the American industry quality award, The Baldrige Award, for the Federal government, are:

- **Top management leadership and support**
- **Strategic planning**
- **Focus on the customer**
- **Employee training and recognition**
- **Employee empowerment and teamwork**
- **Measurement and analysis**
- **Quality assurance**
- **Quality and productivity improvement results.**

In essence, OSF leadership has kept the five phases of quality maturity in mind as well as the critical success factors indicated by the President's Award criteria in the context of its planning for quality. Based on 1991 and 1992 employee survey data, OSF Headquarters employees perceive OSF as being between phases two and three of quality maturity, and that the office has made "start-up" progress in the President's Quality Award criteria categories of: top management leadership and support, customer focus, strategic planning, employee empowerment, and measurement. In the following section, the steps taken by OSF Headquarters in the first two years of its focus on quality are presented. The purpose of the discussion is to provide an example of a NASA organization's approach to quality and the implications for the organization's future as it moves toward the fifth maturity stage of "world class excellence".

INITIAL STEPS

Step 1: Decide to Introduce the Quality Focus to the Organization

Consistent with the NASA Administrator's emphasis on quality and the value for the changes a quality focus would bring to OSF, the Associate Administrator for Space Flight hired a senior manager with a background in continuous improvement in August 1990. The manager's role has been to advise the Associate Administrator, the OSF Management Council, and the OSF Headquarters Senior Staff on the development of a quality strategy for OSF and the introduction of the quality principles and practices to the organization.

Step 2: Develop a Strategic Plan Reflective of Continuous Improvement Principles and Practices

In January 1991, the Associate Administrator for Space Flight convened a meeting of his OSF Headquarters Senior Staff for a weekend strategic planning retreat. The meetings of the team continued through June 1991, and resulted in a strategic plan that reflects a value for customers and suppliers; the OSF workforce; quality, timeliness and efficiency of products and services; and, teamwork.

Step 3: Conduct Employee Diagnostics

In April 1991, OSF sponsored a survey of employees with respect to the following criteria: top management leadership and support, customer focus, strategic planning, employee training and recognition, employee empowerment and teamwork, measures and analysis, quality assurance, and quality improvement and productivity results. Over 25% of OSF Headquarters employees participated in the survey, with a 99% return. In addition, focus group discussions of 6 - 10 employees each were held with representatives from the 15 OSF Headquarters business areas. The results of the survey and focus group discussions were considered by the Associate Administrator, the OSF Headquarters Senior Staff, and the OSF Center and Deputy Center Directors during an OSF Executive Quality Retreat held in May 1991.

Step 4: Conduct Executive Quality Retreat

OSF continued its quality journey by sponsoring an Executive Quality Retreat for the OSF Management Council and Headquarters Senior Staff in May 1991. At the Retreat, business and cultural issues were identified; individual and group values were established; a preliminary vision statement was drafted; a continuous improvement infrastructure was proposed; ways to strengthen OSF communications and methods for involving more employees in OSF decision making were explored; leadership behaviors were reviewed; and, a continuous improvement action plan was developed.

Step 5: Develop Continuous Improvement Infrastructure

OSF Management Council. At the Executive Retreat, the participants agreed that to integrate continuous improvement initiatives into the business mainstream of OSF, the continuous improvement infrastructure should build on existing management mechanisms to the extent possible. Consistent with this philosophy, it was decided that the OSF Management Council would oversee the implementation of continuous improvement in OSF. The Management Council, chaired by the Associate Administrator, consists of the Deputy Associate Administrator and the OSF Center Directors and Deputy Center Directors. The Council has advised the Associate Administrator with respect to the OSF vision, strategic plan and governing principles and encouraged continuous improvement initiatives which cross organizational boundaries (including headquarters/center; center/center; program/program;

headquarters/ program and functional offices; OSF/other agencies/Congress; OSF/customers/suppliers, etc.). The Council meets monthly.

OSF Continuous Improvement Coordination Council (CICC). The OSF Management Council is supported by the OSF CICC, which consists of the continuous improvement focal points from OSF Headquarters and the OSF Centers. In particular, these are the Assistant to the Associate Administrator for Space Flight; the Associate Center Directors at Johnson Space Center, Marshall Space Flight Center, and Stennis Space Center; and, the Deputy Center Director at Kennedy Space Center. The OSF CICC encourages and facilitates cross-center/ headquarters continuous improvement training, teams and communications. The CICC meets quarterly.

*OSF Headquarters Senior Staff.** The OSF Headquarters Senior Staff consists of the direct reports to the Associate Administrator and the Deputy Associate Administrators. This group is responsible for leading and supporting the OSF Headquarters continuous improvement initiatives and encouraging cross-program and functional office teams and headquarters/center team activities. The Senior Staff meets the Headquarters QIC for an extended continuous improvement meeting monthly.

*OSF Headquarters Quality Implementation Council (QIC).** The OSF Headquarters QIC consists of senior and mid-level representatives from each of the eight Headquarters offices. Through its four committees - Measures, Search for Ideas, Communications and Education, and Team Support Services - the QIC initiates, coordinates, and supports implementation of OSF Headquarters continuous improvement actions. It also identifies areas of improvement and serves as an interface between the OSF Headquarters workforce, the Associate Administrator, and the Senior Staff. The QIC has been meeting weekly since the first part of May 1991.

* Note: Each OSF Center has a senior staff and a Quality Implementation Council or similar group of senior officials.

Step 6: Develop Continuous Improvement Action Plan

The OSF Action Plan for 1991 - 1992 was developed by the Associate Administrator and the OSF Management Council as a result of the Executive Quality Retreat held in May 1991. Business and cultural areas addressed in the Action Plan include:

1. Delegate accountability and responsibility
2. Clarify roles and missions
3. Improve communications
4. Develop OSF customers, suppliers, products and services focus
5. Sponsor relevant continuous improvement training
6. Develop an OSF strategic plan reflective of continuous improvement goals
7. Increase employee involvement
8. Improve employee development, training and recognition

9. Streamline shuttle operations processing
10. Review Station Station Freedom from the perspective of the customer
11. Use quality tools to improve space flight programs and services
12. Modernize OSF facilities
13. Develop propulsion testing "center of excellence"
14. Improve OSF Headquarters correspondence and action tracking
15. Develop executive and management information systems
16. Identify relevant work processes and measures.

OSF Action Teams were formed to address most of these areas.

Step 7: Conduct Quality Training

To date, over 400 OSF Headquarters employees, including senior managers, have participated in over 8,000 hours of quality training, including:

- Awareness
- Executive planning
- Senior managers' action
- Advanced team
- Boot camp
- Team Building and Quality Tools
- Team Leader and Facilitation.

The training has been provided in cooperation with Marshall Space Flight Center (Martin-Marietta), NASA Headquarters (Coopers & Lybrand), and Rocketdyne Division.

Step 8: Develop and Implement Communications Strategy

One of the major concerns expressed by the employees in the survey was the lack of effective communications. Improvements which have been initiated by the Associate Administrator, the Senior Staff, and the QIC include:

- Quarterly "All Hands" meetings with the Associate Administrator
- Quarterly Division-specific meetings with the Associate Administrator
- Monthly OSF Headquarters Newsletter
- Quarterly OSF Continuous Improvement Educational Seminars
- OSF Continuous Improvement Clearinghouse
- "Walk around" management behavior
- Employee suggestion system
- Annual employee diagnostic survey.

Step 9: Conduct Inventory of Customers, Suppliers, Products and Services

Each OSF Headquarters office was asked to develop an inventory of its customers, suppliers, products and services. The purpose of the inventory was to: develop

management and general employee awareness of OSF-specific customers and suppliers; serve as the first step towards developing customer and supplier networks, feedback and response systems; and, serve as a complement to a subsequent inventory of division work processes and measures which will be conducted.

Step 10: Represent OSF at/on Agency Quality Forums, Networks and Professional Conferences

To build awareness of current thinking and practices and to participate as a partner in NASA's quality initiatives, OSF Headquarters has participated as a member of NASA quality councils, planning committees, and internal and external evaluation teams. OSF has also provided representation at key quality forums such as the NASA/Contractors' Conference and the Federal Quality Conference.

PROGRESS TO DATE

In the initial phases of quality, a number of products and services have been generated to support the introduction of quality to OSF. These include the following:

Products:

- Measures Handbook
- Team Support Services Handbook
- OSF Continuous Improvement Directory
- Employee Survey Instrument and Report
- Internal Application for the President's Quality Award
- OSF Strategic Plan Reflective of Continuous Improvement Goals
- OSF Continuous Improvement Action Plan
- OSF Customer, Supplier, Products and Services Inventory

Services:

- Quality Infrastructure (ongoing)
 - OSF Management Council
 - OSF CICC
 - OSF Headquarters Senior Staff
 - OSF Headquarters QIC
- Facilitators' Network (ongoing)
 - 22 trained facilitators
- Team Consultation Services (ongoing)
 - Team Building
 - Facilitation
 - Quality tools
 - Measurement
 - Benchmarking
 - Strategic planning
 - Customer, supplier, employee feedback and response systems

- Continuous Improvement Action Tracking System (ongoing)
- Team Quality Materials and Supplies (ongoing)
- OSF Continuous Improvement Clearinghouse (ongoing)
- OSF Headquarters Newsletter (monthly)
- OSF Continuous Improvement Seminars (quarterly)
- Management/Employee Communications Forums (quarterly)
- OSF Continuous Improvement Representation/Liaison (ongoing)
- OSF Continuous Improvement Training (ongoing)
- Employee Diagnostics (annual)
- Employee Suggestion System (ongoing)
- Benchmarking (ongoing)
- OSF Continuous Improvement Strategic Planning (annual)
- Executive Retreat Planning (annual)

CURRENT INITIATIVES

The following OSF Headquarters initiatives are underway as the organization moves from phase 2 in quality maturity to phase 3:

Step 11: Renew the OSF Headquarters Continuous Improvement Strategic Plan

The quality strategic plan is being renewed, with an emphasis on the following strategic thrusts:

1. Ensure OSF management decisions are consistent with the OSF continuous improvement strategic plan
2. Increase customer and supplier satisfaction
3. Improve up, down, and lateral communications
4. Increase involvement of employees and their sense of empowerment
5. Delegate authority to lowest level possible
6. Increase use of continuous improvement tools and teams
7. Develop and recognize employees
8. Enhance use of measurement to determine baselines, goals and progress
9. Evaluate results, modify accordingly, and publicize.

Step 12: Develop individual, group and organization metrics

The Associate Administrator has asked each OSF Headquarters director to work with their respective staffs to develop individual, work unit, and division metrics. The purpose is to develop a baseline of information, establish goals for excellence, and measure progress towards reaching those goals.

Step 13: Form business and cultural teams with a results orientation.

Each OSF Headquarters organization has been asked to establish a minimum of one business and one cultural team, with an emphasis on results. Each team has been asked to provide a charter, milestones, anticipated deliverables, and recognition strategy.

Step 14: Develop and implement an individual, group and organization continuous improvement recognition strategy.

The OSF Action Team which was formed in 1991 to develop improvements in employee development, recognition and training has recommended ways in which recognition can be expanded beyond the traditional individual recognition to one that acknowledges the accomplishments and contributions of teams and organizations. Forms of recognition will be both monetary and non-monetary, with an emphasis on the latter.

Step 15: Practice succession planning as part of employee development.

The OSF Employee Development, Recognition and Training Team has recommended that succession planning be made part of an employee's development in OSF Headquarters. The planning will include individual development plans and specific strategies to provide training, rotational job assignments, mentoring opportunities, and potential progression alternatives as part of an employee's career planning.

Step 16: Include continuous improvement as part of the performance appraisal plans

Specific continuous improvement criteria and performance elements which are qualifiable and quantifiable will be encouraged for each OSF Headquarters employee. The goal is for each employee, starting with management, to be viewed as walking and talking "examples of quality excellence" in all aspects of their business and cultural activities.

Step 17: Develop customer and supplier feedback and response systems.

To complement the employee suggestion system which has been developed by the QIC Search for Ideas Committee, a customer and supplier feedback and response system will be encouraged in each of the OSF Headquarters organizations. Networks

which provide for increased communications between OSF and its customers and suppliers will be fostered. The goal is to enhance customer and supplier planning and operational capabilities through these forums for joint problem-solving and quality process improvements.

Step 18: Implement network management

To date, most of OSF Headquarters' quality efforts have been focused inwardly. Network management - the process of establishing linkages with those critical or related to the business and culture of the organization - enables managers to move beyond the traditional forms of managing to one that is dependent on networking, interactive, and outreach skills - one that seeks accomplishment through teams and the ability to work constructively with those in similar program and/or functional areas within and external to OSF. The interactive networks which are formed provide critical interconnectivity among organizations and serve as catalysts for information-sharing and benchmarking - determining the "best of the best".

LESSONS LEARNED

OSF Headquarters lessons learned to date support the theses of quality implementation espoused by supporters of the President's Quality Award and the Malcolm Baldrige Award:

1. Critical to the success of the initiative is top management **leadership** and support. Without it, the change is piecemeal and suffers from a lack of continuity and comprehensiveness.

2. Also key is early **training** of the employee population, beginning with management and reaching the entire workforce. Particularly important is quality awareness, team building, quality tools, team leader and facilitation training. Without awareness and the skills necessary to initiate quality practices, it is unfair of management to expect quality-like behavior and results.

3. Development of an **infrastructure** provides leadership, communications, planning and implementation forums internal to the organization for the change.

4. A **continuous improvement strategic plan** that sets forth strategic thrusts and implementation strategies provides a framework for the organization to embark upon the quality changes.

5. A strong **communications strategy** enhances employee understanding of the quality initiatives internal and external to the organization.

6. An emphasis on **teamwork** within and across work units provides a critical impetus to the quality initiative. Without teams and the sense of employee empowerment, little progress can be made towards desired results.

7. Key to the success of teams are **facilitation skills** among the members, the team leader or a trained facilitator. These skills enable the team to progress towards its goals and ensure the quality tools and techniques are applied during the team process.

8. The development of relevant **measures and analysis** is critical to establishing baselines, goals and progress indicators key to achieving the mission of the organization and "world class status".

9. **Benchmarking** those which are considered the "best of the best" outside of the work unit in whatever program and functional improvement area is being pursued is key to moving beyond the traditional "silo" management mentality held by most organizations.

10. **Recognition** of individuals, groups and organizations serves as an important incentive to members of the organization in getting started and sustaining the quality initiative.

11. A meaningful and relevant **results** orientation in team formation, process, reporting, and accomplishment is key to successful quality implementation.

12. Key to relevant results is a linkage of the team's efforts to the **strategic planning, management and budget processes.** This ensures the business and cultural change proposals are reflected in the day-to-day operations and future planning of the organization.

13. An **outreach** management approach is essential to the organization's sustained successes and continuous improvements. Effective networks with customers and suppliers and those agencies and companies external to the organization are the channels for improvement suggestions.

14. **Patience** by management and the employees is crucial. As noted by experienced quality organizations, the business and cultural changes embarked upon take time. They require courage, compassion, curiosity and competence - continuously.

IMPLICATIONS FOR THE FUTURE

As OSF Headquarters moves towards quality maturity in phases 3,4, and 5, it is helpful to keep the following implications for the future in mind:

- Quality will be dependent upon a strategic vision, collaboration among all interested parties, the development of a "critical mass" of quality supporters, teamwork at the corporate levels, and systemic planning;

- Communication internal to OSF and with the customer community - predominantly the American public - regarding the "return on investment" in space is increasingly important in times of reduced Federal resources and increased customer expectations;

- The organization may follow the corporate example of "flattening", becoming increasingly dependent on high individual performers who are able to manage through networks;

- Greater use will be made of customer, supplier and employee feedback and response systems as sources of ideas for improvement.

- Greater use will be made of benchmarking as a planning and assessment tool to achieve and maintain world class status.

- Employees will feel more empowerment to form teams and provide suggestions back to management on ways to improve.

- Two-way appraisal systems will become the norm, enabling management and the employees to stay abreast of improvement opportunities in all facets of worklife.

- The NASA Administrator, the President, the Congress, and the American public will expect to see "reader-friendly" tie-ins between continuous improvement initiatives and the agency budget. These will include both cost savings achieved and improvement investments that are quality-related.

- Lessons learned will be shared routinely internally and externally, and results effected by quality initiatives marketed effectively to other agencies, industry, academia and the general public.

CONCLUSION

Through the identification of business and cultural opportunities for change, the formation of teams to address those issues, focus on our customers and suppliers and understanding their requirements, and the application of quality tools to improve processes and solve problems, OSF will be able to meet the challenges of the coming decades and deliver America's future in space - helping NASA to be the "best of the best" in the world.

omit

E Empowerment: Continuing the Journey

This session shares successful experiences, problems encountered, lessons learned, and the value of empowering employees. The panels will explore various definitions and examples of empowerment, the removal of barriers, and the acceptance of ownership.

omit

E1 Empowerment: Concepts, Applications, and Experiences

This panel discusses empowerment from two aspects: empowering yourself and empowerment from a manager's perspective. Definitions, specific experiences, applications, lessons learned, and the value of empowerment to an organization are shared in this informative and active panel.

Clark Maloney, Internal Management Consultant, Craig Developmental Disabilities Services Office, **"Empowering Yourself: The First Step."**

Ray E. Vanderpool, Manager, Northrop Corporation, **"Experiencing Empowerment from a Manager's Perspective."**

OMIT

Empowering Yourself: The First Step

Clark Maloney, Internal Management Consultant
Craig Development Disabilities Service Office
New York State

Everyone is being empowered today. Politicians talk about empowering people, managers talk about empowering employees and teachers talk about empowering students. The word is variously defined but most definitions include giving someone power and authority to make decisions, usually a subordinate. The literature is replete with the virtues of empowerment.

I have two major concerns with empowerment. First, people don't change their behavior just because someone tells them they can change. Changing the environment does help but is only part of the design to fully involve employees. Secondly, empowering someone else means you have power over them. Unless we have self-directed employees we won't have long term benefits to our quality and productivity.

Employees must be self empowered for quality management to succeed. Appropriate training can increase self empowering behavior.

Today I have 4 objectives:

1. Give you my thoughts on self empowerment (internal control) and define it behaviorally.

2. Demonstrate learning techniques to increase internal control.

3. Informally assess your work environments.

4. Discuss the future of empowerment.

As I said empowerment is an elusive word. Delegating to employees the decision-making authority and providing an environment supportive of that authority may be a good start. I question the long term effects.

Everyone is excited about the involvement of employees. I would submit to you that the honeymoon effect of empowerment will soon decease. Neither the environment nor the employee will sustain long term change.

Managers are only looking at changing the authority. I know that training in problem solving, team building and interpersonal communication skills is occurring. Important thought these skills are, they will not help employees make maximum use of the environmental changes. We must teach employees to be self empowered.

Before I define self empowerment let me talk briefly about two concepts that have lead me to this definition.

Julian Rotter, a social psychologist developed the concept of internality or internal control. Internal control means that you are operating on your environment as opposed to responding to your environment. You believe that your behavior determines your rewards.

David McClelland, a Harvard psychologist developed the concept of need Achievement. Simply stated, the need to achieve is a desire to do something well, set challenging goals and reach them. McClelland also studied other needs such as Power and Affiliation.

He researched the characteristics of people with high need Achievement and applied this research. In India, Tunisia and Mexico he taught businessmen these characteristics with great success. In the early 70's the techniques McClelland used to teach these businessmen were used to teach students these same characteristics. We found that internally increased as the characteristics of high achievers were taught.

With that brief introduction let's participate in an achievement game that will demonstrate these characteristics. (The audience will participate in the exercise. The characteristics of high achievers will be identified and a brief discussion will follow. You will be able to compare your own behavior with that of a high achiever or internally controlled person.)

Self empowerment is acting with internal control, i.e., believing that rewards and punishment are contingent on one's own behavior.

Now let's look at the work environments described as empowered.

Four questions:

1. Do they reward risk takers? (punish mistakes)
2. Do they reward creativity?
3. Are employees involved in setting goals.
4. Do opportunities for personal responsibility exist?

SUMMARY

Employees must be self empowered. Empowerment as commonly practiced will not produce long term results.

Managers must be taught self empowering behaviors before they can create "empowered environments."

Do we want all employees self empowered?

Omit

"EXPERIENCING EMPOWERMENT FROM A MANAGER'S PERSPECTIVE"

R.E. Vanderpool — Production Control Manager
Northrop Corporation, B-2 Division

Following is an outline of the motivations, opportunities and techniques we have used to accomplish an environment of self-supervising process performers. As dramatic as the results have been to date, we recognize that this represents the prerequisite to division wide approaches. We are not enthralled by the humanistic rhetoric that most justify as the rationale for empowerment. It is nice to have the more comfortable environment but only as an aside to a better product at a lower cost with higher customer satisfaction.

This outline is rather cryptic and is designed to stimulate your thoughts where they apply to your situation. As the developer and author of this document, I would be pleased to respond to inquiries on any particular item.

It is important that we deal with the focus one more time. When reading the outline, please recognize that all actions taken were for the express purpose of removing non-value steps from our processes. The improvements in the humanistic perspectives all resulted from their successes in accomplishing their daily tasks without accompanying frustrations. The wrong focus will keep you from attaining your business objectives and will ultimately be the demise of your efforts.

DEFINITION

Empowerment — The delegated authority to control processes within the confines of established policies, procedures, and values.

MOTIVATION

- Error filled performances— Backlogs
- Lack of Vocabulary— Jargon
- Conceptions versus reality— Vision
- Benchmark comparisons— Pride
- Frustrations yielding cynicism— Morale
- Lack of value to the customer— Longevity

EMPOWERMENT

Inventory of opportunities which are delegatable when earned (List is not all-inclusive):

- Work Hours
- Safety
- Housekeeping
- Process Improvements
- Equipment Maintenance
- Stop Work Conditions
- Job Assignments
- Customer/Supplier Interface
- Vacation Scheduling
- Peer Level Progressive Disciplines
- Performance Appraisals
- Budget Forecasts
- Compensation Decisions

IMPERATIVE CULTURAL CHANGES

- Managers must maintain Customer/Supplier relationships and provide their associates with all rationalized resources. They control "What" is needed to be done— Structure
- Teams are responsible for "How"— Ownership
- Customers judge success— Accountability
- Meetings must be focused— Participation

IMPLEMENTING PROBLEMS

- Customers/Suppliers not oriented— Commitment
- Team staging varies— Patience
- Teams resisted traditional management duties— Ownership
- Human resource policies conflict with concepts— Transitioning
- Teams lack education and experience— Options

POTENTIAL PITFALLS

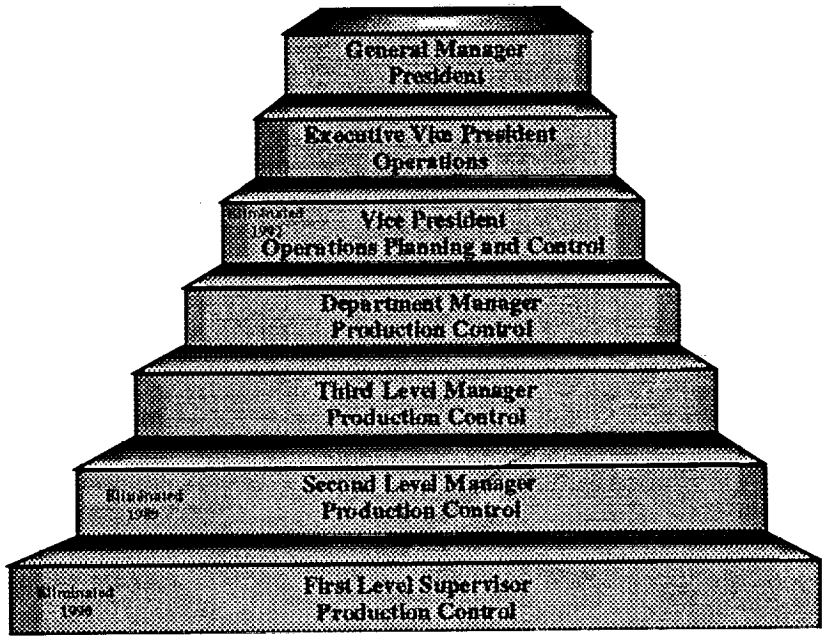
- A lack of commitment to "Make it work"— Courage
- Witholding prudent empowerments— Tentativeness
- Converting to a borderless society without formal and controlled vertical processes— Failure
- Refusing to recognize that "Perceptions are at least as important as performance"— Naivety
- Permissive instead of participative management— Disaster

BENEFITS

- Narrowing the gap between the company and our employees— Purpose
- Good humor and pride developed— Measure
- Expectations were consistently attained— Trust
- We gained a preciseness in terms— Communications
- Improvements became process oriented versus product oriented— Opportunity
- Non-value added steps were identified and eliminated— Productivity
- "What's and How's" began to match— Comprehension
- Proper decisions came more quickly— Empathy
- Process performers became more flexible— Confidence
- Our span of control increased— Efficiency

1988 MANAGEMENT LEVELS

Figure 1.



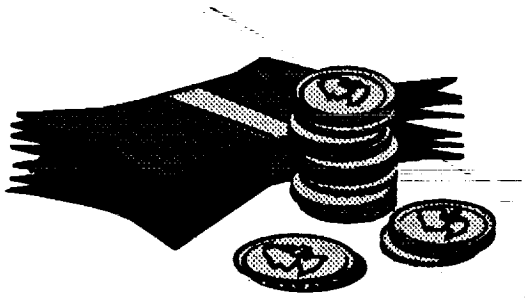
MANAGEMENT ELEMENTS MATRIX

	1988	1989	1990	1991
Number of Managers	18	14	5	5
Levels of Management	4	3	2	2
Budgeted Headcount	147	157	137	167
On Board Associates	144	144	131	145
Span of Control	8:1	10:1	26:1	29:1
Management Salaries	$1,080,000	$910,000	$400,000	$400,000
Payroll Budget	$5,880,000	$6,280,000	$5,480,000	$6,680,000
Percent of Costs	18%	14%	7%	6%
Overtime Expense	27%	17%	12%	15%
	Business as Usual	Management Teaming	Natural Work Teams	Continuous Improvement

BUDGET COMPARISON (PAYROLL ONLY)

Figure 2.

- Average Burdened Labor Costs are $40K per Year in 1988 Dollars



		ANNUALIZED
Budget Allowed 2Q88: 147 People	=	$5,880,000
New Statement of Work: 161 People	=	6,440,000
Rationalized Budget: 308 People	=	12,320,000
1991 Budget Requirements: 167 People	=	6,680,000
Annualized Cost Avoidance (141 People)	=	$5,640,000

FORECASTED DEVELOPMENTS

- Amalgamated job descriptions— Teamwork
- Performance oriented careers— Merit Recognition
- Work instructions equal the process flow diagrams— Command Media
- Self-facilitating teams— Anticipative Management
- Teams dealing with merit and discipline issues— Peer Pressure
- Teams bidding for new expectations— Enthusiasm
- Revenue sharing— Incentives
- Borderless society— Imperative Goal
- Continuous Process Improvement— Excellence
- Customer satisfaction— Success

MAJOR ELEMENTS OF THE PRIMARY PROCESS OWNERSHIP CULTURAL CHANGE

All activities are focused toward continuous improvement within the guidelines established by a values statement.

Never Ending Elements	Date
• Defined "What's versus How's" and a glossary of common terms	Feb 90
• Empowered the teams with process ownership	Jul 90
• Documented the processes	Sep 90
• Established a statistical database	Dec 90
• Contracted Customer/Supplier expectations	Jun 91
• Illustrated objective evidence of improvement	Sep 91
• Renegotiated Customer/Supplier expectations	Sep 91
• Sharing "Primary Process Ownership" with the community	Oct 91
• Benchmark the best partners available	Dec 92

CRITICAL ELEMENT

Leadership— Are you getting more from individuals or groups of individuals than they would provide without you?

-R.E. Vanderpool

E2 Empowerment: Implementation

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Implementation of empowerment will be discussed, including removing barriers and fostering the acceptance of ownership through such techniques as teamwork, recognition and rewards, and coaching and consulting.

Marlene L. Grand, Engineer Specialist, McDonnell Douglas Space Systems Company, **"Empowerment: Some Practical Applications and Their Results."**

Robert A. Carroll, Manufacturing Manager, Strategic Electronics Division, Government Electronics Group, Motorola Corporation, **"Using Empowerd Teams to Achieve TQM/CI Objectives."**

EMPOWERMENT

Some Practical Applications and Their Results

(As practiced by the GNC Shuttle FSW Verification Group)

Panel E2 - Empowerment: Implementation

Marlene Grand
Engineer Specialist
McDonnell Douglas Space
Systems Company - Houston
October 21, 1992

We Are Creating an Empowered Work Environment

We are:

1. Providing input to management decisions
2. Assuming day-to-day management task responsibilities
3. Pursuing improvement opportunities
4. Pursuing new tasks
5. Holding peer group meetings

page 02

Software Requirements

When we were notified that new computer equipment had been ordered, we took steps to ensure that the proper supporting software would also be available. At a teammate's suggestion, the equipment monitor conducted a survey to determine the specific needs for each task in the region of software support. This list was checked by the Equipment Monitor as to the availability of necessary and optional software.

Time/Manpower Decision

Our customer asked us to take on additional work at a very busy time. Instead of making a decree, management asked group leaders for input. Group leaders used their specific knowledge to determine that the task could be done, but not within the exact parameters requested. Group leaders gave a list of what would be necessary to accomplish the task to management, who passed it along to the customer. As a result, we were asked to complete the task within our boundaries. We were not required to drop other tasks, nor did we pass up an opportunity to broaden our work base with out customer.

1. Providing input to management decisions

- We volunteer our opinions to our manager.
- Our manager solicits opinions via weekly status meetings or in short, special meetings.

Examples
Software requirements
Time/Manpower question

page 03

2. Assuming day-to-day management task responsibilites

- Teammates take the initiative to request duties currently handled by management.
- Local problems are solved in a more timely and efficient manner by teammates, rather than management.

Examples

- Flight Coordinator
- Librarian
- Equipment Monitor
- BARF person
- Process documentation
- Daily Technical communications with customer
- Status Sheriff
- Interviewing/Hiring
- Skills Matrix
- Training
- Task Tracking

page 04

Flight Coordinator

Each cycle of flight testing has many testcases, analysts, milestones, meetings, and documents. Keeping track of these was a monumental, confusing task, especially with concurrent testing of several flights. Group leaders suggested that a coordinator be assigned for each flight to direct scheduling, monitor all progress, and be a customer contact in case of questions. The flight coordinator would present a weekly status to management to brief them on any problems and any delays. This position worked so well as an immediate focus for directions and questions that our customer chose to create a similar position to work in parallel with our flight coordinator.

Librarian

Workbooks, documents, and flight related materials are delivered to our group every day. A need was identified for someone to organize this material for more efficient use by teammates. The librarian position was created by group leaders seeking volunteers to perform this task. All information coming into the group is now routed to the librarian, who files the information in an accessible location and catalogues it for easy reference. Now teammates know what information is available and where they can find it. The librarian is always the key person to answer questions about documents and to obtain new documents.

Equipment Monitor

About a two years ago, we were informed by our customer that we were to receive new equipment (terminals, printers, etc). Due to the procurement process used, we had no information on what hardware was purchased, when we were going to receive it, what capabilities it would have, or how it would be installed. The customer, on the other hand, had no idea what we specifically needed to do our jobs. It was obvious that we needed someone who could talk hardware, software, and group needs to ensure that we would receive equipment that would improve our quality and efficiency. A teammate volunteered to contact responsible people, solicit our internal hardware experts for information, determine specific needs, and ensure that we got the best we could out of this situation. As a result, we know much more about the status of equipment and software and have a knowledgeable person to deal with continuing problems.

BARF Person

In the past, management was responsible for the processing of forms necessary to receive and retain user IDs, clearances, and facilities access. A teammate suggested that having someone coordinate this effort would eliminate some confusion and would speed up the process. Thus the **B**adging **A**nd **R**esource **F**acilitator position was created. Acting as a coordinator, the BARF person develops the expertise in the necessary paperwork. This expedites the form submittal process, as well as taking some of the drudgery of paperwork off of the manager. This position also allows development of a working relationship between the BARF person and his or her contacts in the community.

Process Documentation

A teammate began this process by writing a document for the Flight Coordinator Task. Other analysts saw the benefit of having documented procedures and followed with other documents. As a result, the documents provide excellent means for training and have standardized procedures both on our side and our customer's side.

Status Sheriff

Our customer requires us to keep an updated status file for each flight we are currently working on. This information is listed by analyst, thus everyone is required to update their information at each milestone. This tedious process was often forgotten by analysts doing more urgent work, thus resulting in criticism from our customer. An idea was put forth by a teammate to establish a Status Sheriff, who had the specific task of making sure that the status was up to date every afternoon before the close of business. The status sheriff logs on, takes a poll of all analysts' status and makes any needed updates. This buddy system has worked very well and there has been no customer complaint on this problem in over three months.

Interviewing/Hiring

During a period when we were rapidly staffing-up, this group gave every supervisor the opportunity to interview and recommend prospective candidates for hire. This allowed individuals who were most familiar with the current duties of the open position and the necessary skills to have a voice in the process. In addition, the hiring process was made more democratic. This is important because this group has a matrix structure and is team oriented. The results of this practice have been positive. The new teammates hired via this practice had well defined job duties and expectations. As a result, these individuals were able to "hit the ground running" and experienced a shorter learning curve. In addition, the turnover rate of the group has since decreased.

Skills Matrix

One of our Strategic Business Objectives was to increase the proficiency of our employees to a 90% trained level. A teammate suggested a skills database as a means of measuring the level of staff training. A teammate volunteered to assemble a group to outline a format for the task. Valuable skills were identified and each employee's level of proficiency in each skill was recorded to determine the overall percentage of "trained" staff. This quickly identified areas that required improvement. The lessons learned from this task provided valuable inputs to a skills database that was developed for our division at MDSSC.

Training

Since the skills necessary to perform our job effectively are very broad, there is little or no formal technical training applicable to our needs. New employee training is performed by the new teammate's peers and/or their immediate supervisor. These individuals are empowered to determine what material is presented as well as who will present it. This customized training method allows the individuals most familiar with the necessary skills to present the material in a conducive learning environment. This method also allows the trainers an opportunity to improve their presentation skills and to refresh their understanding of the material being presented. As a result of this practice, new teammates have become productive sooner, required less personal monitoring, and their peers have grown in the process.

Task Tracking

Our customer often calls us on the spur of the moment requesting tasks that are needed immediately. Our customer wants these done in addition to our regular tasks, often requiring overtime or neglect of some other task. A teammate developed the idea of recording all of these tasks and requesting official task orders from our customer. We log in each task, perform a manpower estimate, determine a reasonable due date, and contact the customer for approval of this information. This gives the customer a picture of how the task will effect our current work load and will give them an opportunity to reconsider the task's importance. By officially recording these tasks, we have begun to get credit for these "extras" that were previously unappreciated.

Daily Customer Communications on Technical Issues

On non-critical, non-policy related issues, we send direct communication to our customer peer and simply CC the management on both sides. This speeds up the communication process greatly and eliminates "translation" errors from passing questions through many people.

3. Pursuing improvement opportunities

- We continuously look for ways to improve our work processes and environment. We do not wait for others to solve problems that we can solve.
- We have the authority to suggest and implement improvements.
- No process is ever perfect. Improvement can always be made.
- "It has always been that way" is not a reason; it is an excuse.

Examples

- Process Documentation
- Work Flow Analysis
- Internal Reviews
- Cycle Time Reduction

page 05

Process Documentation

We began documenting our processes as a way of standardizing job tasks, training new employees in a more efficient manner and synchronizing our work efforts. In the course of documenting our tasks and procedures, we noticed that many of our procedures were inefficient or outdated. Instead of documenting these procedures as they were and considering ourselves done, we set out to improve the processes. New procedures are tried, and added to our processes. In addition, once the processes are documented, we periodically go back and review them for possible improvements. This group has documented over 20 processes in the last 2.5 years!

Work Flow Analysis

After attending an internal class on Work Flow Analysis, the Ascent team decided to analyze the flow of the Flight Certification Process. On their own, the group tracked the flow of all tasks involved. In the process, potential problem areas were identified. (ie. where work could be held up due to delays, possible communications break downs, inefficient processes, etc).

Cycle Time Analysis

After analyzing the Work Flow of the process, the group went a step further and performed a Cycle Time Analysis. This was to get an accurate idea of exactly how much non-value added time was spent in each area. After problem areas were identified, the group listed as many causes and solutions for each as possible. The Ascent group then took their list of potential solutions and a description of Work Flow/Cycle Time Analysis to the rest of the group and enlisted their help in working the improvements. Many improvements have been completed and a follow up Cycle Time Analysis will be performed soon.

Internal Reviews

In order to improve the quality of work delivered to our customer, we perform internal peer reviews of testcases, documents, etc. This provides an excellent opportunity to catch small errors and to consistently deliver quality products.

4. Pursuing new tasks

- We identify work that our customer is doing that we could be doing.
- We identify tasks that are not being done that could enhance our deliverable product to our customer and to NASA.
- We seek to automate our repetitive tasks.

Examples

- PARaMeter ANalyzer Automation Tool
- New testcase scenarios
- I-Load Checker
- Automation Support Group for analysts
- Group Growth

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PARaMeter ANalyzer Automation Tool

Our current plot analysis tool no longer functions due to changes in the operating system of our computer host. A teammate investigated the possibility of fixing the program, the faults with the current program, and proposals for other tool development, and presented this information to the customer. The customer chose to go with a proposal to create a new tool - PARMAN (PARaMeter ANalyzer). A brainstorming session was held to form a list of tool requirements. Our customer took these suggestions and began a series of working group meetings to implement PARMAN. Money has been specifically allocated for the development of this tool.

New Testcase Scenarios

Questions arose out of a NASA Flight Technical meeting about the orbiter's capability to handle winds at landing. As a result, a teammate developed a testcase where winds at landing could be simulated and the shuttle's performance evaluated. After presenting this test and its parameters to our customer, we were requested to incorporate this test on a flight-to-flight basis.

Automation Support Group For Analysts

A teammate identified the need for a working group to review our tool development and maintenance. A plan was developed to monitor this situation in order to ensure quality products and to focus group attention on automating our work. The teammate outlined a plan for an open forum where anyone could attend, make comments, and alter the group's procedures. After reaching agreement with group leaders and management, a team was formed by requesting volunteers. Though the group is still new, they are already working on 4-5 Change Requests and are researching options for future work.

Group Growth

Our group began doing one type of testing exclusively. As a result of our performance in this area, we were given additional work in three more areas. In each instance, expansion came as a result of teammates expressing interest to our customer. The teammate who was most involved in gaining the work was most knowledgeable and assumed the role of task coordinator. "Entrepreneurship" is a concept taken seriously in this group.

5. Holding peer group meetings

- Everyone below supervisor level attended.
- We used brainstorming techniques to identify problems.
- We added background information on each item in an attempt to determine the root of the problem.
- We brainstormed for possible solutions.
- We divided the information into categories:
 issues solvable by teammates versus
 issues solvable by management.

Examples:	Teammates	Management
	Need for Offline Status	Charge Number Confusion
	Need for "Contact" Sharing	Budget Crunch
	Group Identity	Status Form

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Charge Number Confusion

We use 15-20 Cost Charge Numbers at a time. Some of our tasks fall into "gray areas", thus we occasionally charged work to a Cost Charge Number that was not the customer's choice. Now we ask our customer to clarify any confusion in advance and our management posts a list of all current tasks and their charge numbers.

Monthly Budget Crunch

We are responsible fro delivering a set number of manhours per month to our customer. Some months we have a much greater work load in one area than in others, thus creating an overrun on one charge and a deficit in another. Reacting to this, teammates would be told, often with no warning, that they could not work a task during the last few days of the month. This created problems when work was due and the teammates had been told not to work that charge. As a result of an item in the peer group meetings, our manager now posts hours on a weekly basis so that he and teammates have some advanced warning of how the numbers look. Advance notice allows teammates to juggle less important tasks to ensure that hours needed for priority work are available.

Status Form

Prior to the peer group meeting, the company's status report form turned in by our management contained only upper level business and management information. Many teammates in the group felt that the lack of information on our technical achievements deprived the group of recognition and failed to disseminate information that could be used by other areas of the company. Management was requested to include this information and in response, created a process where group leaders or teammates who feel an item should be included can send that information to the managers with a request that it be put into the status.

Offline Status

Status for each flight (milestones, dates, current progress, etc) was kept only in separate files online. It was impossible for teammates to look at flights concurrently to get a general picture or to access information when not logged on. After a suggestion in the peer group meeting, volunteers created a milestone grid on a white board and placed all relevant flight information on it. This information is highly visible and is updated as necessary. Two hours of effort solved an annoying, time consuming problem.

Group Identity

Being addressed as the "IBM Subcontract Group" caused two major morale problems. First, we were often not identified with MDSSC and were treated as inferior in our own company. Second, the name gave no indication of what we do, thereby denying us recognition and acknowledgement of our accomplishments and skills. As a group we chose a new name; one that reflected our task. We are now the

GNC Shuttle FSW Verification Group.

Offline Status

Status for each flight (milestones, dates, current progress, etc) was kept only in separate files online. It was impossible for teammates to look at flights concurrently to get a general picture or to access information when not logged on. After a suggestion in the peer group meeting, volunteers created a milestone grid on a white board and placed all relevant flight information on it. This information is highly visible and is updated as necessary. Two hours of effort solved an annoying, time consuming problem.

Contact Sharing

As a result of an item in the peer group meeting, it was determined that a list of expert contacts in our field would prevent teammates from having to "re-invent the wheel" each time they searched for an information source in problem solving. A teammate volunteered to collect everyone's individual list of people and topics, combine them into one phone list, and distribute this list to all group members. Now, teammates can refer to their phone list as a means of determining who to call for information on any topic.

5. Holding peer group meetings (Cont'd)

Results:

- Individuals who do not usually speak out also participated.
- Many problem areas identified were not large or technical. Many were morale based.
- Our supervisors formed a team of their own to resolve any problem areas they could.

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Our Understanding

- You are empowered when you know you have the authority to do as much as you are able to do.
- Delegation is not the only way to empower someone.
- To create an empowered environment, every teammate must show initiative, assume authority, accept responsibility, and communicate effectively.

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Our Current Environment

- Responsibility and authority are delegated to the most effective levels.
- Decisions and questions are referred to the individual best able to decide or answer.
- Our leadership roles are based on enthusiasm, willingness, and skill, not hierarchy.
- By teammates volunteering for tasks instead of being assigned, the best person for the job is always used: this person has both skill and enthusiasm.
- Natural working groups are formed to identify and solve problems.

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Summary

- For empowerment to be a part of our natural work environment, we have to change our work habits. This is not easy!
- Some of the actions that we can take are to:
 - ask for volunteers whenever there is an opportunity
 - accept suggestions for improvement from others
 - consider the benefit of the "big picture" whenever making decisions
 - don't allow yourself to be bound by tradition or habit
 - treat your teammates with respect
- Implement quality changes to make your job better, not because you are told to.

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USING EMPOWERED TEAMS TO ACHIEVE TQM/CI OBJECTIVES

Bob Carroll, Manufacturing Manager, Motorola

To most people the success of the space program is the result of the superb state-of-the-art technologies employed and deployed by this enterprise. To those associated with this enterprise, it is the people who have made it successful. It is their talent, judgement, and, most of all, their commitment that has made it happen. Their accomplishments are outstanding, particularly when one considers that their accomplishments have been achieved within organizational structures that were not designed to support this type of activity. These were usually traditional command and control structures with their steep hierarchies, specialized tasks, specialized functions and specialized groups to do the thinking, innovations, and problem solving. The uniqueness of the space enterprise, it's complexity, need for flexibility, and the importance of team work drives the organizational structure away from the traditional model, but this is often viewed as an organization failure. Many organizations expend a considerable amount of energy trying to get back to the model.

This paper hopes to show that this traditional model is the wrong model for both building space hardware and achieving Total Quality Management/Continuous Improvement (TQM/CI) objectives. The organizational model should be high commitment/self managed/empowered work teams supported by a lean empowering organization. This position was derived from the writer's experience in developing empowered work teams and the organizational structure that supports them at the Strategic Electronics Division of Motorola's Government Electronics Group.

Organizations are designed or evolved to accomplish some objective. These organizations consist of people (social system) using tools, techniques, and knowledge (technical system) to accomplish that objective. The organizational design should combine the human and technical elements in such a fashion that the total system's ability to accomplish the system's objective has been optimized. That objective in this case is to design and build, at a competitive cost, an extremely complex state-of-the-art space system. These systems are built from many diverse elements which must work as an integrated whole over an extended period of time without any mission limiting failures.

For building space hardware, variance control must be the single most important feature of an organizational design. To conceive, design, build, and deploy these complex systems is a noteworthy accomplishment, to do it without any mission limiting variances is remarkable. The complexity of these systems combined with the uniqueness of each system make the probability of a variance that would cause a mission limiting failure occurring some place in the process staggering. Stringent procedures have been put in place to capture these variances before they reach the final product: lengthy qualifications, screening of components, tight process controls, and multiple inspections at key points in the process. These have been effective, particularly for the obvious variances, variances that can be observed, tested for, or screened out. The difficulty is detecting the variances that are not obvious, variances that are masked by the process and are

either latent or only occur in certain hardware configuration or under particular environmental conditions. In addition, while these procedures have been effective in capturing the obvious variances, they often do not capture them until they are down stream resulting in costly rework or throw-aways. The organization must be designed so variances are identified and eliminated at the earliest point in the process.

The complexity and uniqueness of these space systems limits the use of a technological solution to capture these variances. The organization must rely on people to do this. The issue then becomes what kind of organizational design will maximize the people's ability to identify and eliminate variances from the product design, the end use requirements, and the best practices in all areas of the enterprise TQM/CI.

For the variance to be identified at the earliest point in the process, it requires the people closest to that process doing the identification. These people are immersed in that process, be it design, manufacturing, or support. If they are trained to recognize variances, they will see them first. The individual engaged in the process can sense very subtle changes in any of the elements that make up their task: the way the materials solder, the way the bit cuts the metal, the sound of the machine, the way the test measurements vary between modules, the layout of a circuit boards, or the variation in data. These observations can start a process that can mean the difference between a successful or a failed mission.

While this ability is essential for variance control the traditional command and control organizational structure works against it. Tasks are fractionalized, often with no consideration for variance control. The causes of the variance may overlap separate groups with separate supervisors. If the person convinces their supervisor of a problem, the problem must be submitted and investigated by the individuals assigned the responsibility of solving problems. This process becomes so burdensome that people just give up and just do what is required.

The solution to this is to train the people closest to the process to identify the causes of the variance and then to empower them to correct the condition which caused the variance. This is best accomplished by empowered teams. When the team sets as one of its objectives variance elimination, each member is strongly motivated to make it happen. In addition, if the entire team is involved in the process they bring a collective seeing and knowing that far exceeds any individual member. This process is enhanced if the team's responsibilities are expanded to remove barriers to variance control, i.e. assign the team responsibilities for a whole product, task or process. As the team takes on more responsibility their commitment to this process increases, they look for other opportunities for improvement. This evolves into continuous improvement in every thing they do (TQM/CI).

For these teams to be effective they require a very different type of organization. An organization that is lean and flexible, that facilitates and enables instead of commands and controls, that maximizes cooperation across all functions and levels, and whose policies empower people and teams.

The success of this model is demonstrated by the following case study.

Case Study: Developing Empowered Work Teams

The process of developing empowered teams at the Strategic Electronics Division started in the Spring of 1987. Since these teams were new to the organization, it was important to find a project that would benefit from empowerment and had enough history to measure its effects.

The COMBO program seemed perfect. The program had excellent leadership, was long enough to allow a slower introduction of empowerment and still benefit from the team development. It had a mature product design requiring very few changes, and it had a long history with a good data base to provide before and after comparisons relative to quality, cost, and schedule. This program had always been successful, but, at this point in time, because of a part testing failure, it had schedule and cost problems requiring special attention.

The writer chose short cycle manufacturing as the methodology for team development because it is a clearly defined process that focuses the entire team on jointly accomplishing measurable improvements in cycle time. The process is simple but powerful. Each reduction in cycle time exposes obstructions to that reduction. These obstructions range from design and process deficiencies to non-value steps throughout the process. Correcting the deficiencies results in a more reliable product. Removing the non-value steps results in fewer hours per unit. As each obstruction or non-value step is identified, the team must decide how to remove it. In the beginning this is relatively easy, but as the process continues it becomes increasingly more difficult. Significant reductions in cycle time cannot occur without a cohesive, cooperative team willing to share tasks and responsibilities.

As we started the process, the program was organized in our traditional method of project management. There was a project leader whose primary tasks were the customer interface and overall project planning and responsibility. He had a production task leader to manage the production effort. This person had a supervisor, three group leaders and two production control people to give direction and to track hardware (see Figure 3). The project was divided into three sections. Each section had a group leader and a separate part of the project. The operators built product in batches as directed by the group leaders. Each person built one type of board.

While it was recognized that this project organization and method of operation would not be needed when an empowered team was in place, it was important that all changes were evolutionary and fit the needs of the team at each stage of team development. We wanted to ensure that the process of implementing empowered teams did not adversely effect this project's performance. The implementation process required small, carefully, thought through steps, taking the time necessary to make sure each step was contributing to the program's success or was, at a minimum, neutral.

Baseline Data:

The first task was to establish the baseline. Flow diagrams were generated on each of the modules. These diagrams showed all operations with delays, movements, and distance moved. Next, the through-put data on every module and system was taken. From this information a flow diagram was developed of the entire system showing best, worst, and average times. This task was performed off-line so that the project was not disturbed. It was completed before starting the process to ensure good before-and-after data. The data was used by the team in their cycle time reduction effort, as well as to measure progress.

Train the Coaches:

The Project Leadership Team (Coaches) was sent through cycle time training before the rest of the team so that they would understand the process, would have buy-in, and would be supportive of the team building process.

Continuous Improvement Meetings:

Continuous Improvement Meetings were put in place to support team formation on a continuous basis. These meetings were attended weekly by all those individuals directly involved in the production phase of the program: Assemblers, Inspectors, Test Technicians, Engineers, Team Leaders, and the writer. These meetings served many purposes, i.e., showing and reviewing cycle time data, communicating program issues, and resolving conflicts or misunderstandings. However, the primary activity was team building.

In the beginning, the Production Task Leader (Coach) chaired the meetings, maintained the minutes, and assigned actions. The minutes were distributed to each member of the team describing the action required, the person responsible to complete the action, the date it was expected to be accomplished, and the current status of this action. While each action was usually small, cumulatively they had a significant impact on improving productivity. Over 800 actions were identified and closed.

The writer attended the meetings to: provide guidance, mentor the Production Task Leader, encourage the participants to voice their concerns and ideas, ensure the actions identified were carried out, and to champion the development of an Empowered Work Team.

Progress Data:

There was a weekly posting of the updated cycle time and quality data: defects per million operations (DPMO), pareto charts, output charts, and cycle time reduction updates. This data was used in the work place and in the Continuous Improvement Meetings to further cycle time reduction efforts.

Formal Training of Entire Program Team:

The formal training of the entire team took place when the Continuous Improvement Meetings hit a lull, and the obstructions became more difficult. The major results of the training were that it expanded the team's knowledge of cycle time reduction, pulled the team together, and reinforced the theme developed in the meetings that significant improvements in cycle time would have to come from the best equipped individuals to accomplish this, the team itself.

One example of how this worked occurred during the early phase. The assembly team requested that instead of building the same board all the time, that each operator be allowed to build a system worth of boards (all the boards required to build a single system). This was agreed to since it had many advantages: greater satisfaction and interest, cross-training, no batching, quality improvement with faster feedback and ownership of the system. The disadvantages were that it took two to four weeks to complete a system, and boards were not always available in the types and quantities needed to build four systems per week.

To remove the disadvantages, the assembly team found a way to produce four systems per week. They set up four systems worth of boards on a shelf and made a list of the boards in the order they should be built. Then each operator took the next board on the list from the shelf, signed it out, and built it. This was done until the four systems were complete. The advantages of this approach were: a full complement of boards for four systems were completed each week, the assemblers felt an ownership for the whole program, and the previous benefits remained.

As the program progressed over time, the following improvements took place:

Batch Construction Replaced by Linear Build

The concept the assemblers had developed of organizing and building four systems per week was refined so the systems were built linearly (one system at a time) and was expanded to the balance of the program. Four work cells were put in place. Each cell had a weekly requirements sheet showing what must be produced during that week. Each cell was self-regulating as to how they organized their work to accomplish the weekly goal. If a cell did not have what it needed, it went to the previous cell to pull it.

Project Stockroom Established

A project stockroom was established in the project area to cut down the cycle time associated with obtaining kits from the central stockroom, thereby reducing the overall cycle time to manufacture a system. The project stockroom filled kanbans in place of working to a kit schedule. As each system was assembled, the tote bins (kanbans) were returned to the project stockroom and refilled, automatically keeping the kitting in balance with assembly. A single individual was assigned the responsibility for all kitting. Where there was no contact in the past, there was now a positive interaction between the assemblers and this person. Many good ideas passed back and forth between them. During peak needs, the assemblers were cross-trained to perform kitting tasks and the stock person was cross-trained to do assembly tasks.

Production Control Function Eliminated

Each person moved their own hardware to the next work cell and logged it on that work cell's weekly requirement sheet. These sheets statused the program and provided all the cycle time data. All out-shelves were removed. The program's words for this were, "Your out-shelf is the next person's in-shelf". The flow of hardware was controlled by the kanbans and weekly requirement sheets. The entire flow was pulled by system test needs.

Entire Team Worked To Fill Critical Capacity Resource

The program was planned to an overall monthly schedule, but each cell worked to a sheet that told them what their weekly output should be. It listed the work in systems worth of boards so that the previous system was completed before the next system. This way there was always the correct mix of boards. These sheets were adjusted to conform to the needs of system test. System Test was the only detail schedule. The system test equipment was the critical capacity resource. Working this equipment to what used to seem its capacity, tested sixteen systems in four weeks. With cycle time modifications that alternated the order of performing certain tests, sixteen systems were tested in three weeks. This was a gain of over sixty systems per year with the same equipment.

Self-Directed Team Established

After about two years of this continuous improvement and growth the Team was self-directed, functioning without a Supervisor, Group Leader or Production Task Leader. Motorola and the customer contract set the rules, policies and procedures. The project defined the overall objectives, schedule, cost, and quality. The Team (hands-on personnel) determined the best methods for meeting these objectives within those rules. This put the day-to-day decisions in the hands of the individuals most competent to understand, accomplish, and make continuous improvements on how the tasks were accomplished.

Self-Directed Team Trained In Interactive Team Skills

As the Team took on the tasks of managing the day-to-day activities, conflicts started to arise. The writer asked for assistance from the Organizational Developmental Department to train the Team in the use of interactive team skills. That Group trained the Team two hours a week over an extended period of time. At first the Team did not feel they needed these skills, but as the skills development progressed, and the team started to use them, they came to appreciate their importance. With the use of these new skills, there was an increased understanding, trust and collaborative spirit between the team members. This allowed the Team to take on progressively higher levels of responsibility for their project's success.

High Commitment Team In Place

The Team now had the same Project Leader who did essentially as he did before, customer interface and overall project planning and responsibility. The floor activities were managed by

this High Commitment Team, Operation Associates, and Test Technicians (see Figure 4). These individuals took turns every two weeks attending the projects leader's morning meeting, chairing the Continuous Improvement Meeting, doing the tasks the Production Task Leader, Supervisor, and Group Leader performed. Each person tracked their own defects, participated in the daily planning, gave and accepted direct feedback on their performance from fellow team members and took responsibility for making sure the project goals were met.

A typical day would start at 7:30 AM with a 15-minute Stand-Up Meeting. All the hands-on team members would attend. They called it their Ownership Meeting. Each member would state the defects or problems they caused or encountered the previous day, state why they felt it occurred and what they thought could be done to eliminate it. The purpose of this process was to alert the other team members of potential problems, to involve the rest of the Team in permanent solutions to the problems encountered and to heighten each person's sensitivity about the importance of doing zero-defect work.

The assembly cell member whose turn it was to attend the 15-minute, 8:00 AM, Test Status Meeting would join the Project Leader with the Test Cell member to determine what had to be accomplished that day to meet the test equipment schedule. That person would then return to the assembly cell, state what had to be pulled forward to make the scheduled vibration dates. The Team would develop a quick plan that would accomplish this within the constraints of having the required hardware into customer inspection by 3:00 PM so it would be ready for staking, masking, and conformal coating by 3:30 PM to allow an overnight cure. The Team would then operate to that plan and accomplish all the tasks required. The test cell member would do the same. Both cells kept each other informed on any changes that had to be made to the morning plan.

The inspector, who was an integral part of the Team, kept a running status of the assemblies required to complete each system in the order needed. She used this status to prioritize her work so the assemblies were inspected in the order that would meet the test schedule.

The linear build combined with the reduced cycle time and work in process, allowed the entire Team to be aware of every piece of hardware through its production cycle. They knew where it was, where it should be, and what had to happen next. They knew why each delay occurred and took measures to prevent it in the future. This continuous, constant feedback resulted in an continuous, constant improvement in the product and process. This total team focus on quality and product flow produced significant improvements in the project's performance.

Outstanding Results

Cycle times were reduced four fold; 22 to 5 weeks (3 weeks being Fixed Test Time). Quality improved more than thirty fold in two years (DPMO of 750 reduced to 25). Production hours per unit were significantly reduced and support labor was reduced from 19 to 4 people. Space needs were reduced from 8,000 to 3,500 square feet. (See Appendix for detailed data.)

These results reflect the Team's sense of purpose, competence, and commitment. They had gone from a team in disarray where, as one person described it, "I hated to come to work and only did what was required.", to the point where that same person stated, "I am working harder than I ever have in my life, and loving it.". This change took place because the project's success became their success. It was their planning, their doing, their checking, and their improvements that made it happen.

SUMMARY

The above hopefully demonstrates that the objective of a lean empowering organization is to release the vast untapped reservoir of creativity presently locked up in our organizational structures. Empowerment neutralizes the filters, baffles and barriers that have been built into our traditional structures to make them manageable, where creativity has been throttled down so a single individual can direct and control the daily activities of 10 to 20 individuals - span of control. By designing organizational structures that trust people to manage themselves we start to approach the potential of what our organizations should be.

APPENDIX

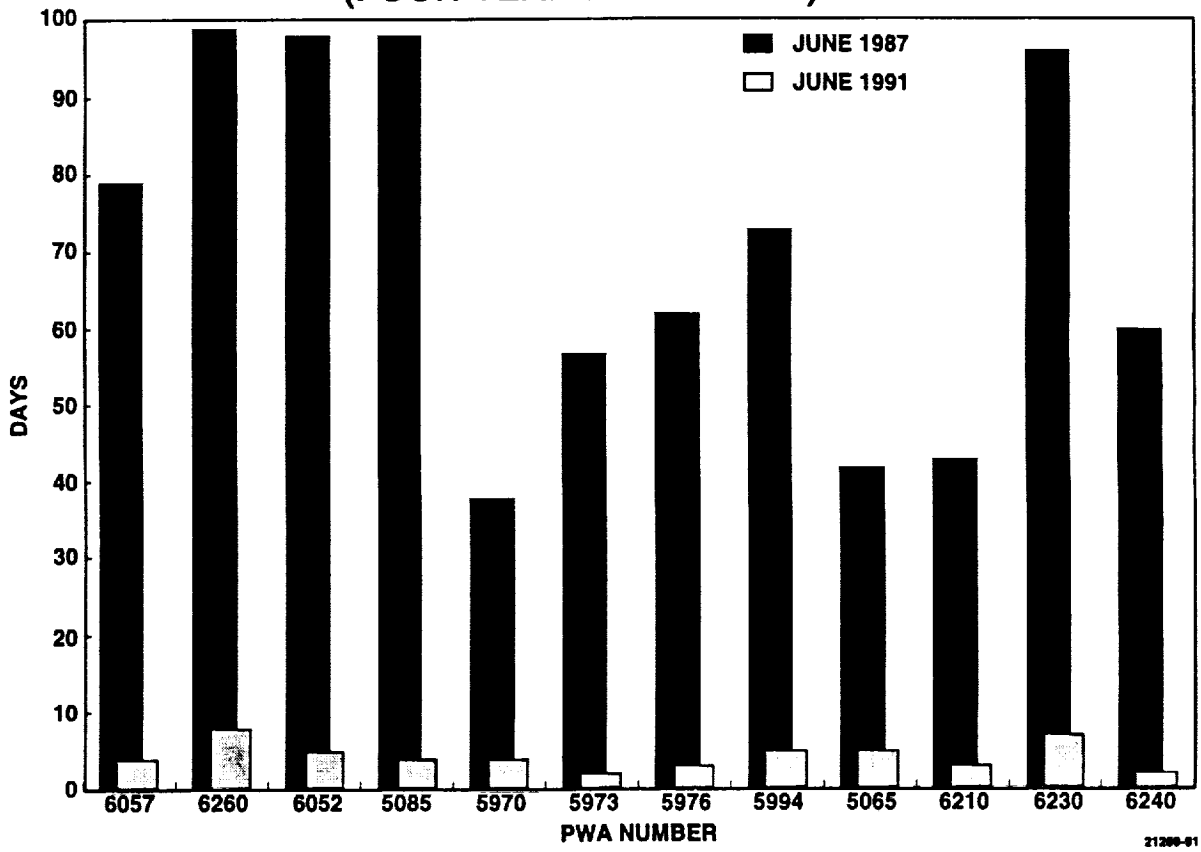
COMBO

PERFORMANCE

DATA

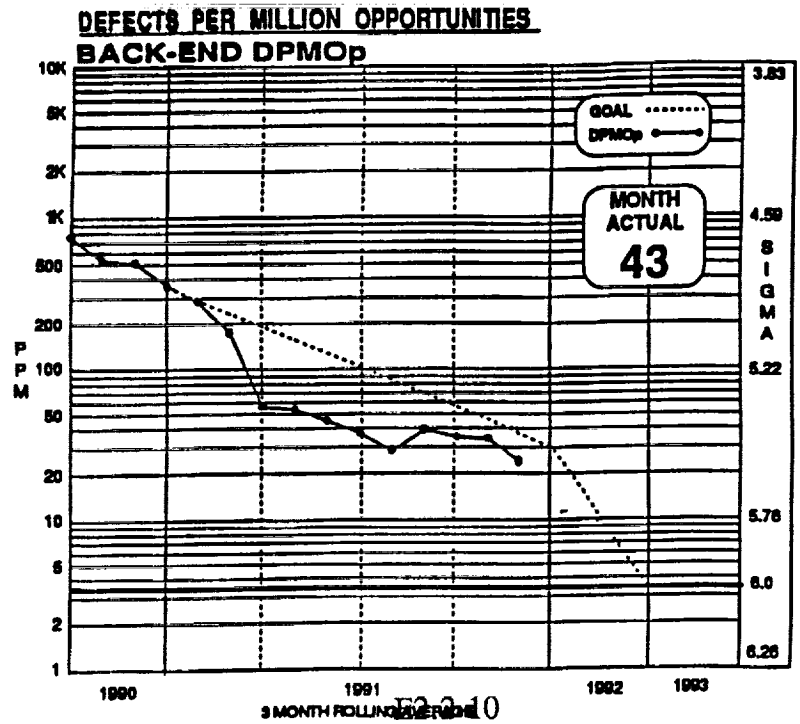
COMBO PWA CYCLE TIMES

(FOUR YEAR REDUCTION)



SED QUALITY SUMMARY REPORT

PROGRAM/AREA: COMBO V



COMBO
PRODUCTION ORGANIZATION CHART
JUNE 1987

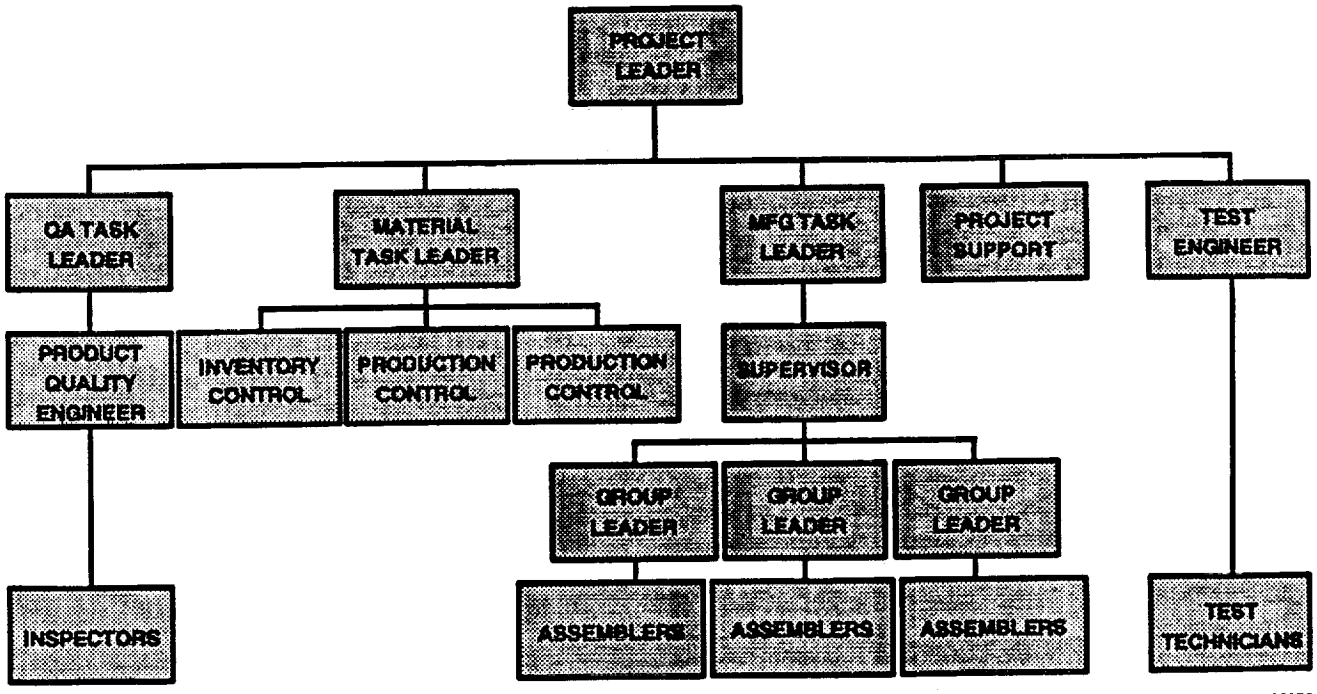


Figure 3

COMBO
PRODUCTION ORGANIZATION CHART
JUNE 1990

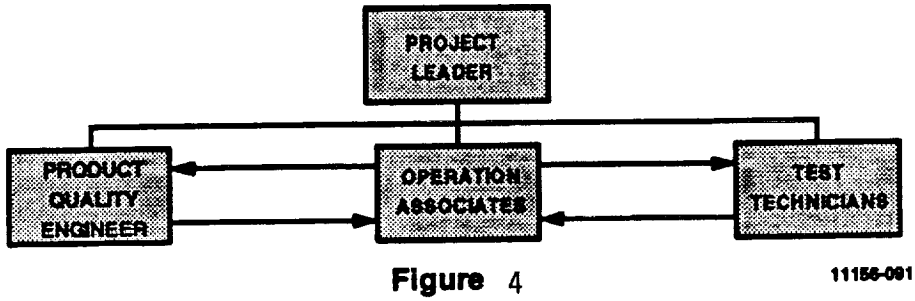


Figure 4

CHARTS DO NOT INCLUDE NON-PRODUCTION FUNCTIONS, ENGINEERING, MATERIAL, DATA MANAGEMENT, AND THE PROGRAM MANAGER

AMT

E3 Empowerment: An Interactive Discussion

The benefits and issues (including overcoming fears and fostering trust) of empowering will be discussed. Through hands-on activities you will be challenged to leave your comfort zone and experience empowerment.

John D. Howell, Vice President, AND **Bill Ingram**, President, Performance Dynamics Group; AND **Don Grogg**, President and Chief Executive Officer, Texas Process Equipment Company, **"Experience Based Learning for Organizational Development."**

EXPERIENCE BASED LEARNING FOR ORGANIZATIONAL DEVELOPMENT

John D. Howell, Vice President, Business Development

Bill Ingram, Director, Performance Dynamics Group

Don Grogg, President, Texas Process Equipment

The study of human behavior is a never ending process, but most educators agree that behavior is learned and to some degree can be changed. All learning programs are composed of experiences, whether they are conducted indoors or out. Some experiences, however, are more experiential than others. Several criteria have been established to help determine effectiveness. One would be that an experience becomes fuller when it is less mediated - by language, and more directly sensory in nature. A learning event becomes more experiential when one is involved in the planning and execution of the activity. The degree of experience increases as participants become more responsible for the experience that occurs, and more responsible for mastering related activity. At its upper register, the scale of planned experience-based learning merges indistinguishably with activities of life.

The first key to experiential approach is that people learn best as a result of their own experiences. While most traditional teaching and training methods focus on the "trainer" disseminating information by way of lectures, charts, graphs, videos, and overhead projectors, the experiential approach has the participants actually engaged, physically and mentally, in specific tasks carefully designed to emphasize desired behaviors, issues, and outcomes. The games, initiatives, and events provide real problems which require participants to use their leadership skills, problem solving skills, communication skills, and teamwork to reach real solutions, in a compressed time frame. Thus, the facilitator, skilled in group process techniques, observes and captures "teachable moments" in the whole "process" from start to finish.

Another key to effectiveness is in translating the "metaphoric" behavior back to real workplace behavior. Metaphoric learning is based on the theory that each person has learned one basic way to play all "games". In other words, the individual's values and belief systems provide the basic framework, the "rules", within which they operate most of the time. Given this assumption, the skilled facilitator can observe and ask questions following each exercise that will allow the individuals, and groups, to examine their own behavior, and how it impacts the other members of the group, the process, and the end product. The integration, or transference, of the learning from each exercise is guides from generic to specific applications. Likewise, each exercise builds on the lessons

learned from previous exercises. The end result is that the participant will, through carefully guided facilitation, learn the lessons from "within", by doing, recreating, and applying the metaphoric learning to specific workplace behavior. All of this is done in a supportive, trusting, and fun environment that leaves participants energized and excited, rather than bored and tired.

The final step in the process is to convert the learning from the course into specific written action plans generated through group discussion and interaction. Since the primary focus on the physical activities and subsequent processing has been on positive intervention, safety advocacy, teamwork, trust, improved communication, and other specifically identified issues, the action for each major action plan will also be assigned by the group to assure team follow up.

Can people learn to trust, communicate, support each other, and positively intervene and advocate safety for themselves and others, all while playing games and having fun? Can you think of a better way?

A SCALE TO MEASURE THE LEVEL OF EXPERIENCE IN AN EXPERIENCE-BASED PROGRAM

LEVEL OF EXPERIENCE	PARTICIPANTS ACTIVITIES
1. Lecture	Passive, receptive
2. Simulated	Sees movies, TV, slides
3. Spectator	Sees the real thing in its normal setting
4. Exploratory	Plays, experiments, explores, probes the setting
5. Analytical	Studies the setting and experience systematically
6. Generative	Creates, builds, organizes, theorizes or otherwise produces
7. Challenge	Sets difficult, but desirable tasks to accomplish
8. Competence	Strives to become skillful in important activities
9. Mastery	Develops a high standard of quality in performance
10. Personal Growth	Pursues excellence and maturity as a person

F Synergism of Partnering

This session will explore the benefits of synergistic interaction that result from successful partnering. Panels will focus on two general areas: the strategic teaming necessary between education and industry for the future and the tactical teaming required today throughout the supply chain (government, prime contractors, subcontractors, suppliers, and unions). Some of the benefits of partnering include reduced cycle time and cost, enhanced customer satisfaction and educated, flexible, and motivated work force and electorate.

F1 Partnership in Education - A Requisite for Excellence

This panel will discuss the shared commitment between industry and education to achieve excellence in K - 12 through partnering. The focus will be on:

- Approaches and Techniques in partnering and
- Case Studies

John B. Winch, Program Manager, **AND Herb W. Wallen**, Communications System Engineer, Space Station Freedom, Missiles and Space Division, Boeing Defense and Space Group, **"The Boeing Chapman Project - Using Space Station Freedom to Teach the Business of Science."**

Sue Collins, Manager, Education Strategic Initiatives, Apple Computer, Inc., **"Building Effective Partnerships."**

Boeing's Chapman Project: Using Space Station Freedom to Teach the Business of Science

John B. Winch, Program Manager, Space Station Freedom Program, Boeing Defense & Space Group

Herb W. Wallen, Communications System Engineer, Space Station Freedom Program, Boeing Defense & Space Group

It has been the long-standing policy of the Boeing company to be involved in the community. One of Boeing's corporate tenets is, "Quality as measured by customer, employee and community satisfaction." An important part of creating community satisfaction is making investments in education. The Boeing Company has established a K-12 mission which is, " Provide leadership and support in the continuous improvement of K-12 educational achievement, leading to world class educational systems, students and graduates." Boeing's K-12 mission statement supports our nation's education goal adopted by President Bush and the National Governors Association: "By the year 2000, U. S. students will be first in the world in science and mathematics achievement." This goal is achievable if business and industry actively participate in their community educational systems.

Frank Shrontz, Chairman and Chief Executive Officer of the Boeing Company and Vice Chairman of the New American Schools Development Corporation, appointed by President Bush, shows Boeing's commitment to education by stating, "Providing our children with a world class education is not just desirable, it's a matter of our national survival. The challenge is too big for one sector of society to tackle alone. That leaves us no real alternative but to foster a true partnership of effort from individuals and groups in both the private and public sector."

One way Boeing Defense & Space Group in Huntsville, Alabama has played a role in support of corporate and national policies on education has been to establish a partnership with Chapman Middle School. This partnership began in 1990 with a direct appeal from Chapman's principal to Boeing senior management for assistance in addressing on-going problems with discipline and motivation among Chapman students. Over eighty percent of the students attending Chapman Middle School were considered "at-risk", i.e., they had learning disabilities (25%) and were from low socio-economic families (55%). There was a good chance they would not finish high school much less continue with higher education. Boeing employees met with some of the teachers at the school to see what type of partnership could be formed to add value to the school program. After several meetings, a consensus was reached

to form a team of Boeing managers, engineers, computer specialists and Chapman teachers to inject some real world experience into the education process.

The project was implemented with a three-fold approach: 1) a Speakers Bureau that emphasized how school curricula could be used as building blocks for future success, 2) a Computer Resource Team which promoted computer literacy through field trips and hands-on computer activities, and 3) an Engineering Design Team which used the government contracting process to demonstrate to the students how reading, writing, communication, computers and social skills - as well as math and science - all tie to the business world.

The Engineering Design Team was the major thrust of the Chapman Project and the focus of this paper. The team used the "Request For Proposal" approach, requiring eighth graders to design, build and demonstrate a water purification system. This exercise took the students through the proposal, preliminary design, preliminary design review, detail design, critical design review, and award stages of a contract to build a working prototype of the water purification system. Students and teachers were presented with supplier statements of work and detail design specifications of the requirements to design and build systems using distillation and filtration methods for purifying water.

The mission of the Chapman Project was to motivate students to stay in school, develop skills needed for success in a technological work environment, and create a link between the eighth grade science curriculum and the work Boeing does locally on the Space Station Freedom Program. Special emphasis was placed in the math and science area. The goals of the project were:

- Relate the importance of school curriculum to industry.
- Provide role models.
- Improve academic performance of students.
- Enhance career awareness.
- Stimulate a greater interest in math and science.

The Chapman Project also hoped to demonstrate to the middle school students that the curricula being taught in school, i.e., mathematics, science, art, history, etc., are of significant value and provide fundamental skills they will need to compete when they enter the job market. Additionally, it was to let them see that the Boeing employees participating in this project were also at one point middle school students, and are now successful adults, thus providing role models.

Boeing Engineers implemented the Engineering Design Project using the following approach:

Introduction

Boeing representatives introduced themselves to parents, teachers and students during a meeting of the PTA. The basic goals and approach of the Chapman Project were presented. Students and teachers were subsequently introduced to the engineering process by lecture and projects which required comparative decision-making. Students were divided into small groups to simulate competing companies.

Requirements

Students were issued a supplier statement of work, detail water purification specifications and data item descriptions which would drive their design.

Proposal

Students submitted a proposal in seven parts as different assignments illustrating the concepts of their water purification system design including:

- Water purification overview
- Proposed method of water purification
- Detailed parts list for prototype and estimated cost
- Time keeping method
- Estimated work schedule to completion of project
- Functional schematic of system
- Front view drawing

Preliminary Design Review

Students were required to develop presentation charts and "sell" their design to Boeing. All groups that had completed the required work were given the authority to build their prototype.

Detail Design

Preliminary Designs were refined and more detailed engineering drawing were submitted. An Operating Manual fully describing the assembly, operation, safety hazards, caution and warnings and disassembly instructions was submitted. A Financial Report was prepared which included a log itemizing all hours spent on each assignment for the project. This was used to determine a grade for each team member's participation. The Prototype was built according to detailed design drawings submitted. Students used their resources and Boeing's to obtain parts while maintaining an imposed twenty-five dollar limit.

Critical Design Review

Students displayed prototypes and demonstrated how the requirements were met for size, function and performance. Samples of filtered ersatz waste water were tested for organic, inorganic, particulate and general contamination in Boeing's laboratory.

Award Stage

Students were awarded with visits to the Space Station Freedom mockup, Pre-development Operational System Test, and a day at the U.S. Space and Rocket Center in Huntsville, Alabama. All students were awarded certificates, and the team with the best design received a trophy.

The Chapman Project proved to be a very successful program that provided a positive learning experience for both the students and the engineers. The students and teachers learned that an engineering team required more than just technical capability. It required teamwork, dedication, communication skills, writing ability, creativity, and self-esteem. The most successful teams were the ones that worked together and were concerned about the quality of the work they submitted to Boeing. The students discovered that a seemingly impossible job could be accomplished by planning and delegating tasks. Tim Lull, the principal of Chapman Middle School states, "Through the task (team) concept, the students experienced first hand the importance of each member's responsibility to the successful conclusion of the project. The students learned from the Chapman Project that each could offer critical skills and ideas that contributed to the team effort."

Students learned that the fundamental principles that they applied in designing their water purification system directly correlated to the principles being used in the design of the water purification system for Space Station Freedom. They also discovered that the curriculum they were taught in school could be applied to a real world project.

Most of the Boeing engineers involved in the project had 0-3 years experience on the job. This program helped teach many of them how the RFP method worked, and gave increased understanding concerning the problems the prime contractor may have with its subcontractors. Beginning engineers are not often exposed to the proposal process, and following it from beginning to end gives a good overview of what is required to complete a proposal. The importance of communication was stressed when there was confusion concerning the requirements for the engineering drawings. The engineers learned that some of the things they took for granted were not obvious to an eighth grade student. This lesson can be easily carried over into the "real world" because miscommunication is probably one of the most expensive problems in industry today.

Empirically, the success of the program can be measured by the overall rise in grades for the Chapman eighth graders since the initiation of the Project. From 1990 to 1991, the Chapman test scores in the national Stanford Achievement Test (SAT) test rose 18% in math, 8% in science, and 7 % in English. These increases are percentile increases, and indicate the relative standing of Chapman Middle School students in comparison with students in the same grade nationwide. Also, during this period, the student's attendance increased by 27%, a very key factor to the students' future success.

There have been many lessons learned during the course of the Chapman Project. Some of these lessons are listed below:

- Students understand better with hands-on experience.
- Providing role models enhances student involvement and success.
- Explicitly define the teacher's role up front.
- Maintain a strong communication link with the teacher.
- Determine clearly defined and agreed upon goals and objectives.
- Assure educators that the partnership created will be a learning experience for both parties.
- Parents get more involved in their children's learning through partnerships of this type.

An industry and education partnership is beneficial to both parties. Students need to see what opportunities exist for them to work towards, and need to be exposed to the technology/skills they will need to master later in life. By coming to schools and showing students what they are doing, industry is providing the building blocks for the students to create goals for their future and motivating them to achieve these goals. Industry is planting the seeds for its future as well. Very capable students that may have chosen not to complete high school and go on to higher education may now continue forward and use their skills to help industry stay competitive in an increasingly changing market. Hopefully, someday, these students will have the opportunity to continue the cycle that began with the Chapman Project.

For further information about the Chapman Project and other K-12 education programs, please contact:

Government and Community Affairs
Boeing Defense & Space Group
Missiles & Space Division
P.O. Box 240002, JW-54
Huntsville, AL 35824-6402
(205) 461-2278

Building Effective Partnerships

Sue Collins, Manager, Education Strategic Initiatives
Apple Computer, Inc.

Paper not available for publication.

F2 Trust ----> Partners ----> Benefits

Achieving and maintaining world class excellence requires all the partners in the supply chain (government, prime contractors, subcontractors, suppliers, unions) to work together as a team. This panel will describe how NASA, prime contractors, and suppliers established successful partnerships in the Space Shuttle Program which resulted in significant process improvements and cost reductions.

Charles S. Harlan, Director, Safety, Reliability and Quality Assurance, Lyndon B. Johnson Space Center, AND **Alfred A. Boyd, Jr.**, Vice President, Safety, Reliability, Maintainability, and Quality Assurance Operations, Loral Space Information Systems, **"Johnson Space Center Total Quality Partnership."**

Bohdan I. Bejmuk, Program Director, Space Shuttle Integration, Rockwell Space Systems Division, AND **Lawrence G. Williams**, Program Manager, Space Shuttle Engineering Integration Office, Lyndon B. Johnson Space Center, **"A Shared Vision: Partnership of NASA and Rockwell International in Cost Effectiveness Enhancements (CEE) for the Space Shuttle System Integration Program."**

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NASA Johnson Space Center Total Quality Partnership

Charlie Harlan - NASA JSC SR&QA
Sam Boyd - Loral Space Information Systems

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Abstract

NASA JOHNSON SPACE CENTER

CONTINUOUS IMPROVEMENT PARTNERSHIP

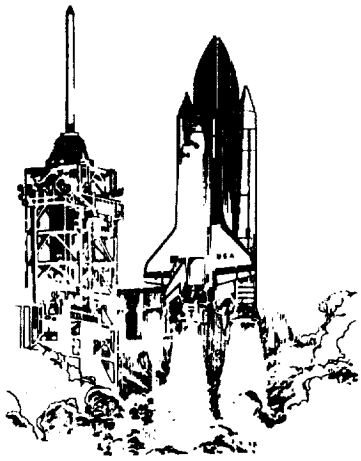
This presentation traces the development of and benefits realized from a joint NASA, support contractor continuous improvement process at the Johnson Space Center (JSC). The joint effort described is the Safety, Reliability and Quality Assurance Directorate relationship with its three support contractors which began in early 1990.

The Continuous Improvement effort started in early 1990 with an initiative to document and simplify numerous engineering change evaluation processes. This effort quickly grew in scope and intensity to include process improvement teams, improvement methodologies, awareness and training. By early 1991, the support contractor had teams in place and functioning, program goals established and a cultural change effort underway. In mid-1991 it became apparent that a major redirection was needed to counter a growing sense of frustration and dissatisfaction from teams and managers. Sources of frustration were isolated to insufficient joint participation on teams, and to a poorly defined vision.

Over the next year, the effort was transformed to a truly joint process. The presentation covers the steps taken to define vision, values, goals and priorities and to form a joint Steering Committee and joint process improvement teams. The most recent assessment against the President's award criteria is presented as a summary of progress. Small, but important improvement results have already demonstrated the value of the joint effort.

Mr. Charlie Harlan is the Director of Safety, Reliability and Quality Assurance at the Johnson Space Center, and Mr. Alfred A. "Sam" Boyd is Program Manager and Vice President for the major support contractor, Loral Space Information Systems.

Space Shuttle Program

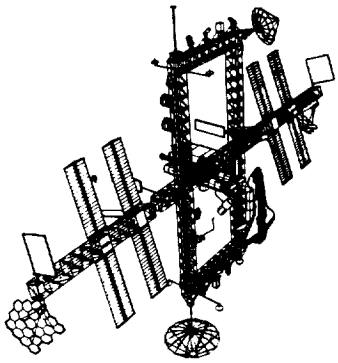


STS-50 JUNE 25 - JULY 9

- MANNED VEHICLE
- LONG DURATION MISSION
- EXTREMELY NARROW MARGINS
- HAZARDOUS FLUIDS
- EXTREME LOADS
- COMPLEX SYSTEMS

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Space Station Freedom Program



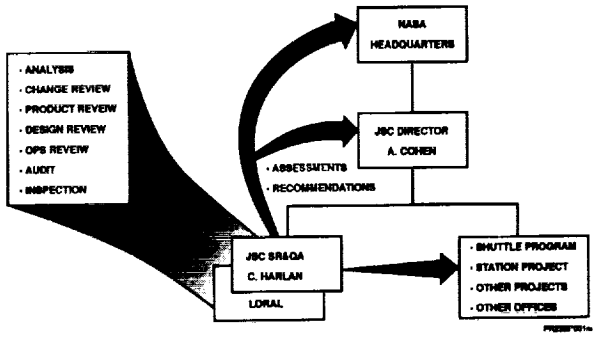
SPACE STATION FREEDOM

- PLANNED 1995 FIRST LAUNCH
- PERMANENTLY MANNED
- 30 YEAR LIFE
- COMPLEX, SOFTWARE INTENSIVE SYSTEMS
- LOW MARGIN LIFE SUPPORT
- RESUPPLY DEPENDENT

3 PR2366

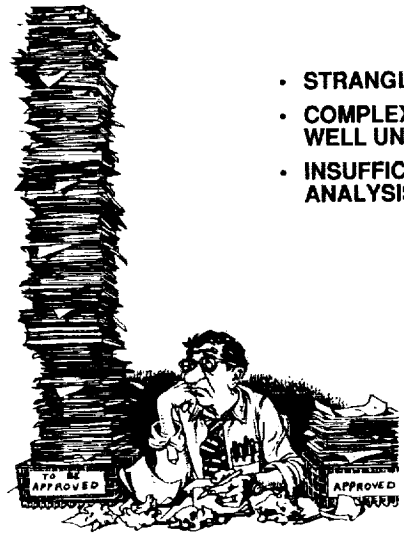
Safety, Reliability, and Quality Assurance Role

- PROVIDE ASSESSMENTS AND RECOMMENDATIONS TO SENIOR NASA MANAGERS



PR2355

Where We Started



- STRANGLED BY PAPER
- COMPLEX PROCESSES, NOT WELL UNDERSTOOD
- INSUFFICIENT ENGINEERING ANALYSIS

WE WERE PROCESSING *TOO* MUCH PAPER THAT TOOK UP *TOO* MUCH TIME

PR2355

Evolution of Loral Total Quality
1990 to Mid 1991



- BEGINNINGS
 - CUSTOMER DEMAND FOR PROCESS DOCUMENTATION AND SIMPLIFICATION
 - FEE BASED ON CONTINUOUS IMPROVEMENT
- LORAL TQ RESPONSE
 - DOCUMENTATION – 40 PROCESSES
 - EDUCATION AND AWARENESS BEGINS — JULY 1990
 - TQ PLAN — AUGUST 1990
 - TQ STEERING COMMITTEE — SEPTEMBER 1990
 - TEAMS — NOVEMBER 1990
 - GOALS AND MANAGEMENT TEAM BUILDING — JANUARY 1991
 - CULTURE SURVEY — MARCH 1991
 - RECOGNITION PROGRAM — MAY 1991

Problems

- NO STRATEGIC DIRECTION
- NASA INVOLVEMENT WAS NOT ADEQUATE
 - ON TEAMS AND IN STRUCTURING THE PROCESS
 - JOINT PROCESSES BUT CONTRACTOR-ONLY PROGRAM
- A HOST OF PERIPHERAL PROBLEMS
 - COMPETITION FOR EMPLOYEES TIME
 - BUY-IN FROM SUPERVISORS
 - UNFOCUSED TRAINING
 - PRESSURE FOR EARLY SUCCESS
 - INATTENTION TO CULTURE



Joint Total Quality
Mid 1991 to Present



- RECOGNITION OF GENERAL FRUSTRATION
- JSC STRATEGIC PLANNING AND TQ INITIATIVE — MARCH 1991
- JOINT TQ ACTIVITIES
 - JSC SR&QA/CONTRACTOR JOINT RETREATS — MARCH - OCTOBER 1991
 - JOINT TEAMS — JUNE 1991
 - PATHFINDER TEAMS — AUGUST 1991
 - JOINT STEERING COMMITTEE — AUGUST 1991
 - JOINT MISSION STATEMENT, GOALS, VALUES — OCTOBER 1991
 - IMPROVEMENT OBJECTIVES — DECEMBER 1991
 - JOINT RECOGNITION PROGRAM — IN WORK
 - EMPOWERMENT INITIATIVES — APRIL 1992
 - TQ ASSESSMENT CAPABILITY — MAY 1992

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Typical Teams

- PARTS APPROVAL PROCESS — NASA LEAD, JOINT MEMBERSHIP
- WORK PLANNING — LORAL LEAD, JOINT MEMBERSHIP
- FMEA/CIL — LORAL LEAD, JOINT MEMBERSHIP
- OPERATIONS REQUIREMENTS — LORAL LEAD, JOINT MEMBERSHIP
- CHANGE REQUEST PROCESS — LORAL LEAD, JOINT MEMBERSHIP
- ADP SUPPORT — LORAL LEAD, JOINT MEMBERSHIP
- SAFETY SUPPORT — LORAL LEAD, JOINT MEMBERSHIP

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Q+ Team Membership

- COCHAIRS – NASA SR&QA AND LORAL
- MEMBERSHIP
 - NASA SR&QA 8
 - LORAL 6
 - BARRIOS 1
 - WEBB MURRAY 1



10 PR2358

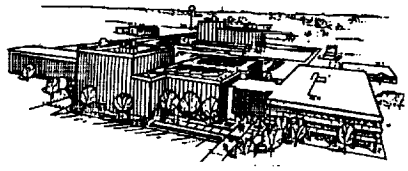
Joint Steering Committee

- COCHAIRS – CHARLIE HARLAN AND SAM BOYD
- MEMBERSHIP
 - NASA SR&QA 7
 - LORAL 3
 - SIMCO 1
 - WEBB MURRAY 1



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Where Are We Now



- MISSION AND VALUES
- STRATEGIC GOALS
- DIVISION/DEPARTMENT IMPROVEMENT OBJECTIVES

TQ BENCHMARK

TQ Elements / Status Level	A MANAGEMENT LEADERSHIP AND SUPPORT	B STRATEGIC PLANNING	C FOCUS ON THE CUSTOMER AND PARTNERS	D EMPLOYEE TRAINING AND RECOGNITION	E EMPLOYEE EMPOWERMENT AND TEAMWORK	F CONTINUOUS IMPROVEMENT MEASUREMENT AND ANALYSIS	G CONTINUOUS Q/A ACTIVITY	H QUALITY AND PRODUCTIVITY IMPROVEMENT RESULTS
5	• Top Executives Directly/ Actively Involved In Quality-Related Activities • TQ Is Number 1 Priority • Long-Term Top Management Commitment • Everyone Held Accountable for Improving Processes	• Short-Term and Long-Term Goals for TQ Established Across Organization • Customer/Supplier Issues Incorporated Into TQ Plans • Benchmark Data Used Extensively	• Innovative Methods for Obtaining Customer Feedback • Effective System Links Feedback with Groups That Can Act on Data • Customer Contacts Fully Empowered	• All Personnel Trained in TQ • Plans Fully Integrated into Strategic Plans • Formal Processes Exist To Recognize Employees with Emphasis on Teamwork	• Innovative, Effective Employee Involvement Approaches • Cross-Functional Team Cooperation Occurs • Positive Suggestion Trends • Worklife Quality Improving • Strong Employee Empowerments	• Continuous Improvement Progress Tracked in All Areas • Data Available to All Users • Information Collected Is Complete • Data Validity Checks Routinely Made • Employees Routinely Use Measures	• All Products Reviewed To Meet Customer Needs • Process Optimization Methods Are Used Routinely • Methods Emphasize Prevention, Not Detection	• Most Significant Indicators Demonstrate Exceptional Results • Superior to Competition All Areas • Customer Satisfaction over Past 5 Years • Results Clearly Related to TQ • Results Sustained at High Levels
4	• Top Executives Participate In Quality Councils and Other Leadership Activities • TQ Is a Number 1 Priority of Most Groups • Adequate Resources Invested In TQ • Communication Is Two-Way	• Short-Term and Long-Term Goals for TQ Established Throughout Most of Organization • Customer and Supplier Issues Are Factors in TQ Planning • Benchmark Data Used	• Effective Feedback System for Obtaining Customer Information and Improving Services • Systems Linked to Groups That Can Act on Data	• Training Plan Being Implemented and Evaluated for Effectiveness • Nearly Everyone Trained • Extensive Management and Peer Recognition	• Some Innovative Involvement • Some Cross-Functional Teams • Employee Suggestions Growing • Teams Increasing • Most Workers Empowered • Periodic Survey Process • Team Contributions Evident	• Continuous Improvement Progress Tracked in Most Areas • Data Available to Most Users • Most Information Collected Is Complete • Data Validity Checks Made • Most Employees Use Measures	• Majority of Products Reviewed To Meet Customer Needs • Methods Emphasize Prevention, Not Detection	• Most Significant Indicators Demonstrate Excellent Results • Competitive in All Areas • Customer Satisfaction Rising • Results Related to TQ • Resulting Improving • Results Contribute to Organization's Mission
3	• Most Top Executives and Managers Support TQ Which Is a Significant Priority for Many Groups • Some Resources Invested • Communication Is Sometimes Two-Way • Top Management Committed to Long-Term TQ	• Short-Term Goals for TQ Established in Key Parts of Organization • Customer Needs/ Expectations Influence TQ Planning • Benchmark Data Readily Available	• Customer Feedback Regularly Solicited for Management Action • Supplier Quality Monitored • Most Groups Aware of Customer Needs	• Training Plan Being Implemented on Schedule • Most of Organization Trained in TQ • Individuals and Teams Recognized for Improvements	• Majority of Managers Support Employee Involvement • Several Cross-Functional Teams • Some Employees Empowered • Evidence of Improvements Informal Surveys • Plans To Expand Employee Involvement	• Quality Information Collected from Major Customers • Data Available to Senior Managers • Many Work Units Use Measures • Information Collected Is Usually Complete	• Key Products Reviewed To Meet Customer Needs • Methods of Process Optimization Used • Product Standards Set for Some Internal Support Areas	• Most Significant Indicators Demonstrate Good Results • Competitive in Many Areas • Customer Satisfaction Exists • Results Generally Improving over Past 3 Years • Performance Improving over Past 2 Years
2	• Many Top Executives and Managers Support TQ • Some Resources Allocated to TQ • TQ Projects Underway • Most Aimed at Short-Term Payoff • Communication Is Usually Top-Down (Sometimes Two-Way)	• Improvement Goals Established by Management • Customer Needs Generally Known for Key Products Considered in TQ Planning Process	• Most External and Some Internal Customers Identified • Needs Identified ad hoc Rather Than Systematic Methods • Feedback Systems Report on General Satisfaction/ Dissatisfaction	• Training Plan Under Development • Many Units Trained in Group Problem Solving • Recognition in TQ Employed in Many Units • Number of Awards Increasing	• Many Managers Support Teams • Some Teams Established • Empowerment Growing • "Ownership" of Improvement Growing • Number of Involved Employees Growing • Employees Queried Regarding Overall Satisfaction	• Quality Information Collected from Some Customers • Limited Data on Quality • Some Work Units Use Quality Measures • Information May Not Be Complete	• Few Products for External Customers Reviewed and Controlled To Meet Customer Needs • Methods Used Emphasize Detection Not Prevention	• Most Significant Indicators Demonstrate Improving Results, Including Customer Satisfaction • Improvements Achieved in One or More Dimensions/ Areas • Quality of Suppliers Generally Improving
1	• Top Executives Beginning To Support TQ Activities • Support Tentative • Few Resources Allocated to TQ • Few TQ Projects Underway • Communication Is Primarily Top-Down	• General Goals Contain Elements of TQ • Quality Planning Not Yet Integrated with Overall Strategic Planning • Customers' Needs May Not Be Routinely Considered	• Customer Complaints Are Primary Method of Feedback and Not Systematically Used To Improve Processes • Many Work Units Have Identified Customers and Their Needs	• Many Managers Attended TQ Awareness • Plans To Increase TQ Training • Minimal TQ Training Resources • Recognition Primarily for Individual Effort May Not Be Focused on TQ	• Some Managers Support Employee Involvement • Small Percent of Employees Participating • Traditional Suggestion System • Improvements Result from Complaints • Only General, Nonspecific Improvement Plans	• Feedback Systems Providing Information on Quality • Quality Data Generally Not Available • Data Used for Reporting, Not Improvement • Few Work Units Use Measurement • Quality Information Collected on ad hoc Basis	• Products for Customers Reviewed/Controlled To Meet Internally-Developed Specifications • Quality May Not Be a Priority for Suppliers	• Some Results in One or More Areas • Results Achieved in One or More Dimensions/Areas • Little Evidence of Improvement Trends

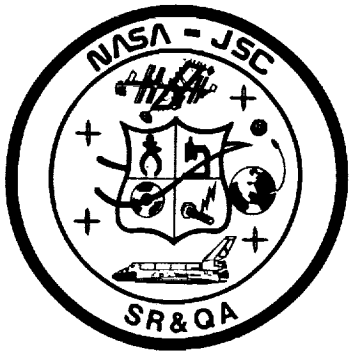
DESIRED DIRECTION ↑

DEGREE OF LINE INVOLVEMENT →

Figure E-3. TOTAL QUALITY BENCHMARK – *We Assess Our TQ Culture Every 6 Months To Our Status Level in Eight TQ Elements. These Elements Are Used To Select the Recipient of the President's*

SR&QA Mission Statement

We as the SR&QA Team in partnership with our customers, assure the success of NASA programs through both technical expertise and innovation.



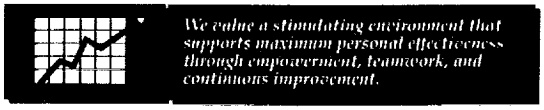
PEOPLE



PRODUCTS



ENVIRONMENT

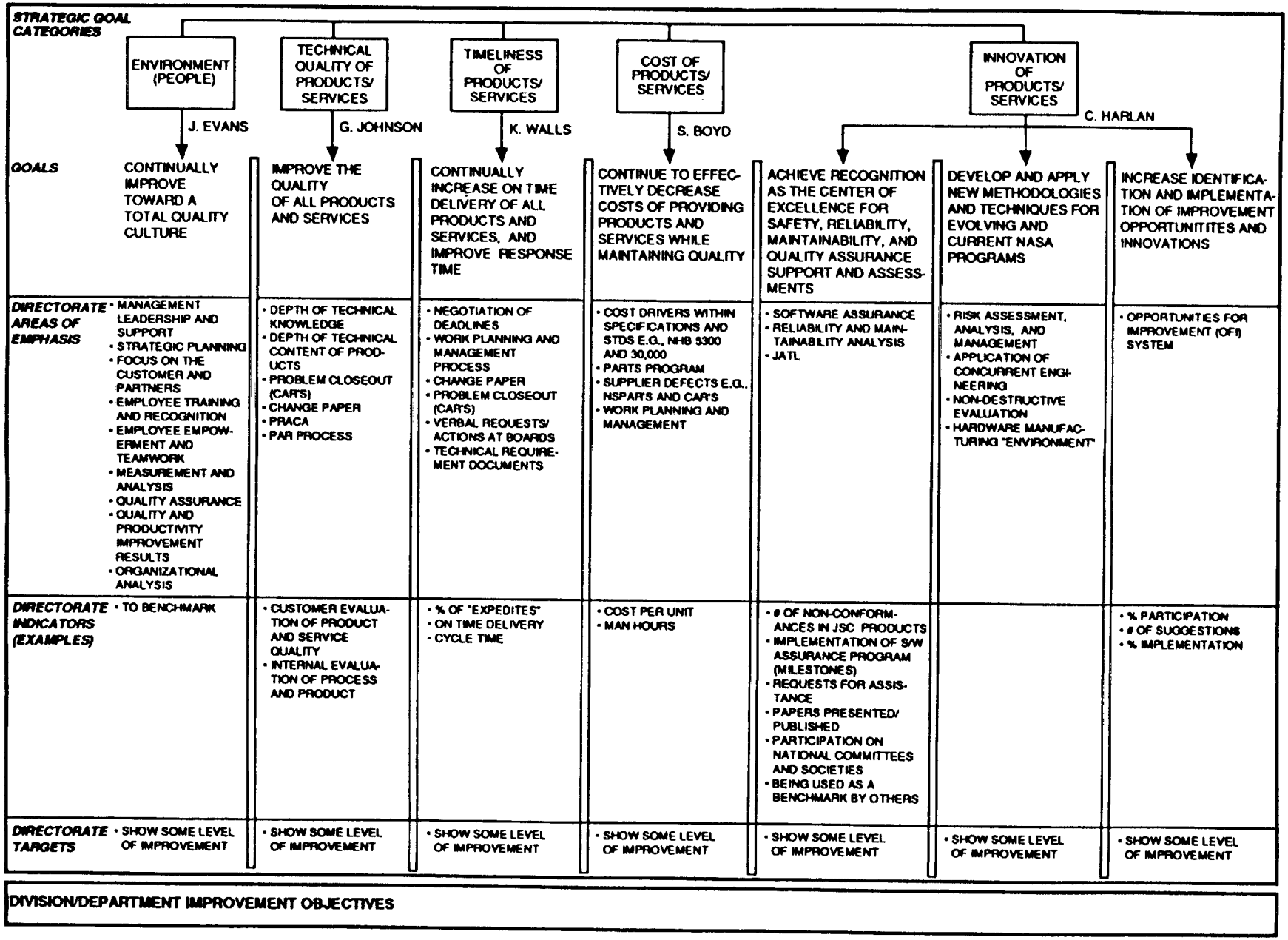


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PR2385

ORIGINAL PAGE IS
OF POOR QUALITY

Strategic Goals and Division/Department Improvement Objectives



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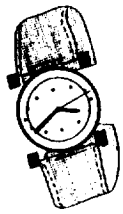
First Successes



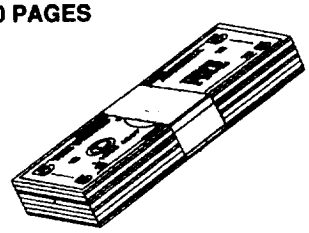
15

FMEA/CIL Process Modifications

- THE SOLUTION ELIMINATES PAPER CHANGES WHICH TRANSLATES INTO



	ANNUAL REDUCTION
REPRODUCTION	369,890 PAGES
MAN-HOURS	17,000



- THE POTENTIAL TOTAL COST AVOIDANCE IS ESTIMATED TO BE $688,000 ANNUALLY

16

NSPAR Process Modifications
Estimated Savings

- VOLUME OF REQUESTS 2183
- MANHOURS 15135
- COST $545K OVER PROJECT LIFE

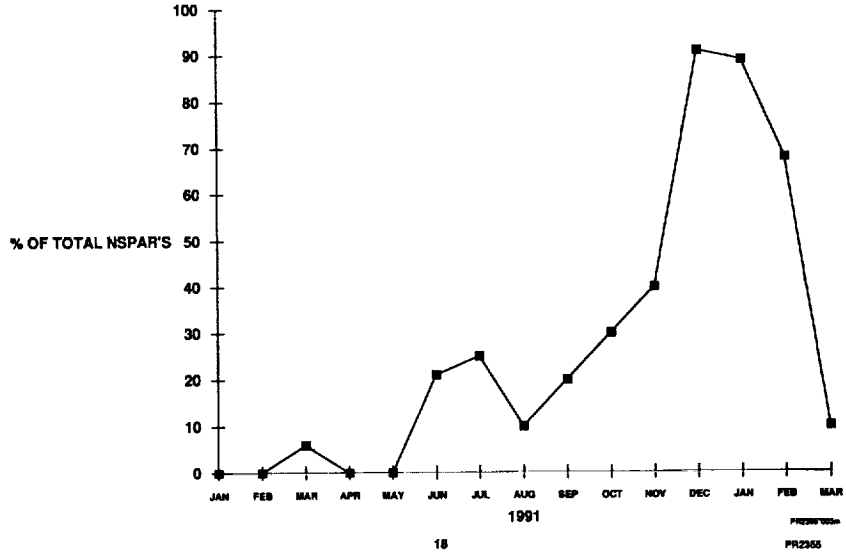
- SCHEDULE - NONSTANDARD PART APPROVAL CYCLE REDUCED 18 MONTHS
 - CURRENT PROCESS – 24 MONTHS
 - NEW PROCESS – 6 MONTHS



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PR2365

NSPAR Approval Rate

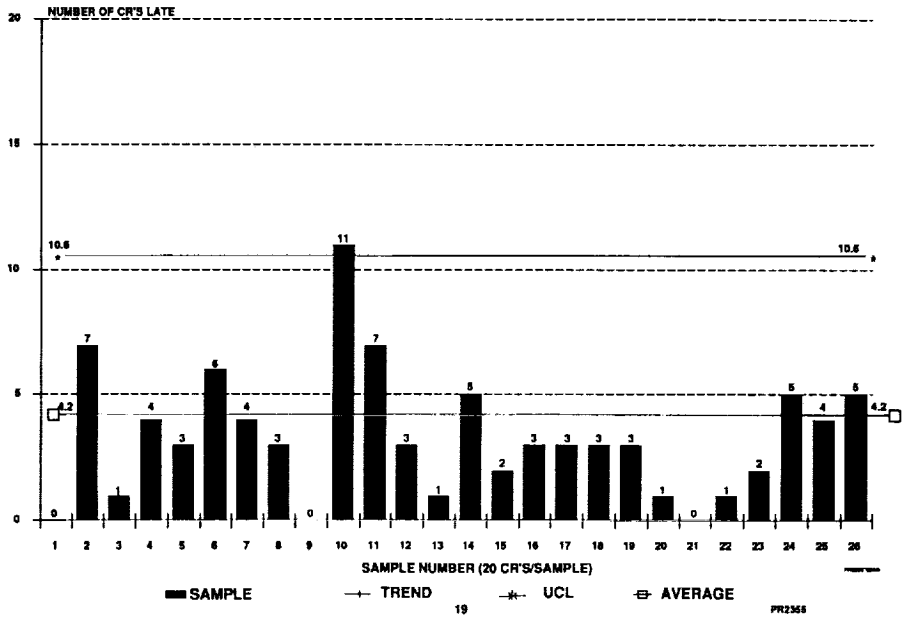


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Space Shuttle

Summary for Processing as of 04/09/92



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Suggestions

- LAST 10 MONTHS – 233
- PREVIOUS 6 MONTHS – 10

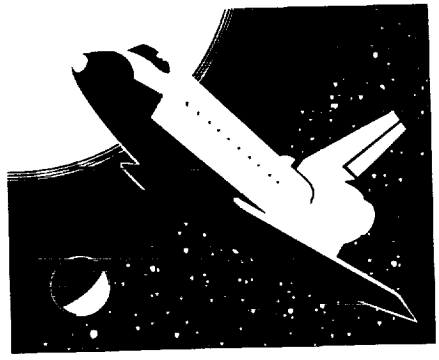


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PR2355

Where Are We Going

- CULTURE
- TEAMS
- TRAINING
- MANAGERS
- IMPROVEMENT OBJECTIVES

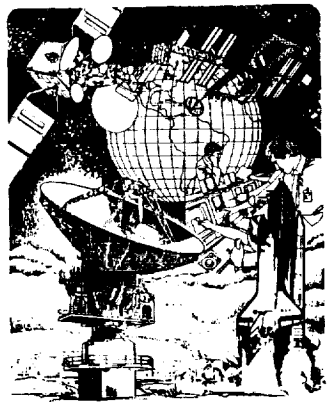


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PR2366

JSC Vision
Pioneering Space Exploration

"AT JSC WE ARE ALL PIONEERS CHARGED WITH THE ENVIABLE TASK OF IMPLEMENTING THE DREAMS THAT NOT TOO LONG AGO EXISTED ONLY IN THE WORLD OF SCIENCE FICTION."

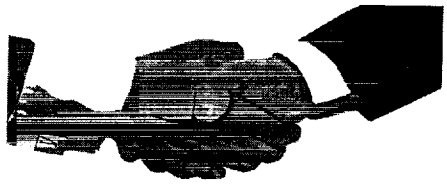


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PR2365

A Shared Vision:

Partnership of NASA and Rockwell International in Cost Effectiveness Enhancements (CEE) for The Space Shuttle System Integration Program



Ninth Annual NASA/Contractors Conference on Quality and Productivity

Presented by:
Larry Williams, NASA
and
Bohdan Bejmuk, Rockwell International

Ninth Annual NASA/Contractors Conference
on Quality and Productivity

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Title: Shared Visions: Partnership of Rockwell International & NASA Cost Effectiveness Enhancements (CEE) for the Space Shuttle System Integration Program

Presenters: Bohdan Bejmuk - Program Manager, Space Systems Division, Rockwell International
Larry Williams - Program Manager, NASA - Johnson Space Center

Abstract:

As a result of limited resources and tight fiscal constraints over the past several years, the defense and aerospace industries have experienced a downturn in business activity. The impact of fewer contracts being awarded has placed a greater emphasis for effectiveness and efficiency on industry contractors. It is clear that a reallocation of resources is required for America to continue to lead the world in space and technology. The key to technological and economic survival is the transforming of existing programs, such as the Space Shuttle Program, into more cost efficient programs so as to divert the savings to other NASA programs.

This presentation describes the partnership between Rockwell International and NASA and their joint improvement efforts that have resulted in significant streamlining and cost reduction measures to Rockwell International Space System Division's work on the Space Shuttle System Integration Contract. This work was a result of an established Cost Effectiveness Enhancement (CEE) Team formed initially in Fiscal Year 1991, and more recently expanded to a larger scale CEE Initiative in 1992. By working closely with the customer in agreeing to contract content, obtaining management endorsement and commitment, and involving the employees in TQM and continuous improvement "teams," the initial annual cost reduction target has been exceeded significantly.

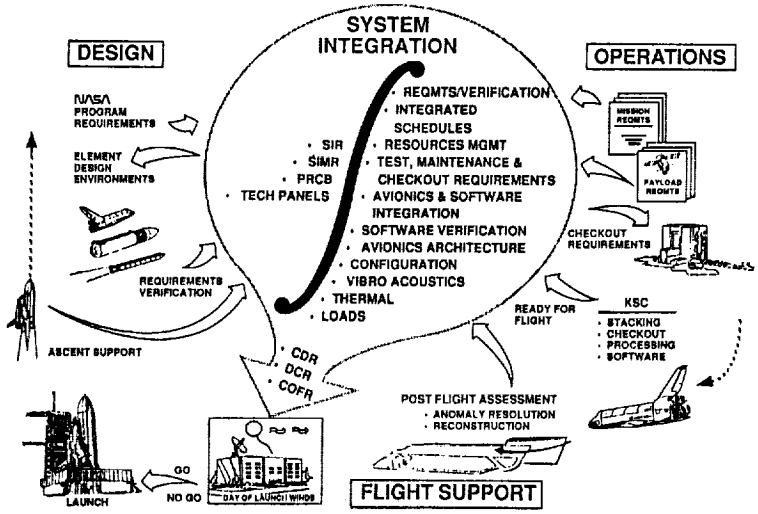
The CEE Initiative helped reduce the cost of the Shuttle Systems Integration contract while establishing a stronger program based upon customer needs, teamwork, quality enhancements, and cost effectiveness. This was accomplished by systematically analyzing, challenging, and changing the established processes, practices, and systems. This examination, in nature, was work intensive due to the depth and breadth of the activity.

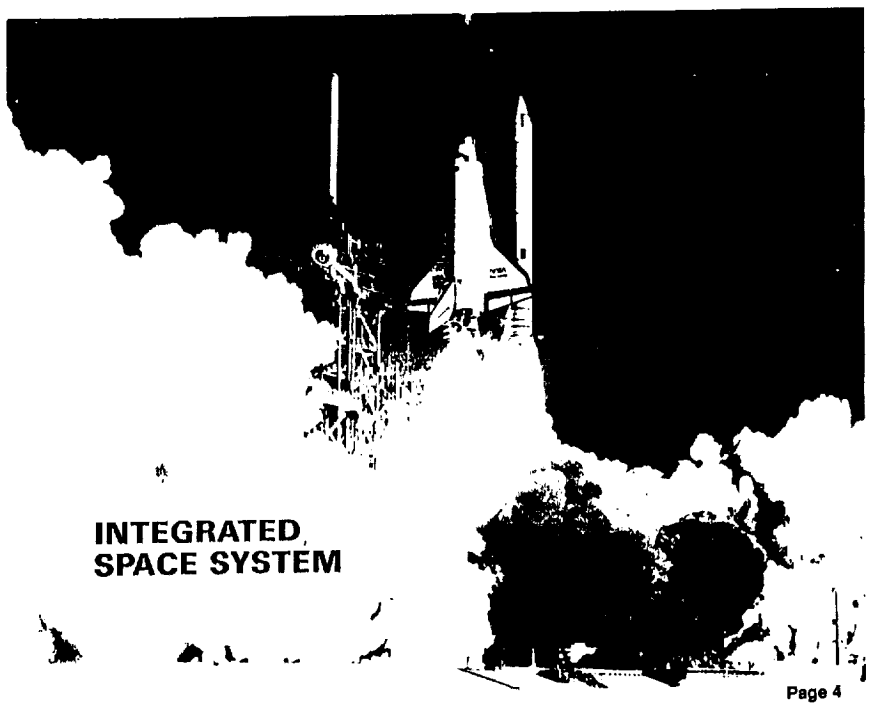
The CEE Initiative has provided opportunities to make a difference in the way Rockwell and NASA work together -- to update the methods and processes of the organizations. The future success of NASA space programs and Rockwell hinges upon the ability to adopt new, more efficient and effective work processes. Efficiency, proficiency, cost effectiveness and teamwork are a necessity for economic survival. Continuous improvement initiatives like the CEE are, and will continue to be, vehicles by which the road can be traveled with a vision to the future.

Presentation Outline

- WHAT IS THE SYSTEM INTEGRATION CONTRACT?
- WHY PURSUE AN IMPROVEMENT INITIATIVE?
- WHAT WAS THE GOAL?
- HOW DID WE GET THERE?
- WHAT WERE THE RESULTS?
- WHAT DID WE LEARN?
- WHAT'S NEXT?

Rockwell Has Performed All System Integration Tasks On The Space Shuttle





Page 4

Why Did We Start Cost Effectiveness Enhancement Initiative?

NASA'S VIEW

- EXTERNAL CRITICISM OF SHUTTLE COST
- FREE UP FUNDS FOR OTHER PROGRAMS
- IMPROVE VALUE OF CONTRACTOR'S PRODUCTS
- BECOME A PATHFINDER FOR SHUTTLE PROGRAM

ROCKWELL'S VIEW

- DESIRE TO IMPROVE COMPETITIVENESS - STAY IN BUSINESS
- WANTED TO BE PROACTIVE IN COST EFFECTIVENESS



- IMPROVED COST EFFECTIVENESS - WIN-WIN FOR ROCKWELL AND NASA

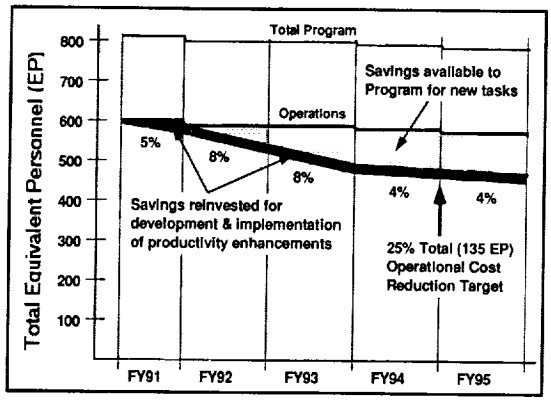
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Page 5

NASA/RI Common Goal: Make the System Integration Contract More Cost Efficient

JOINTLY ESTABLISHED TWO PARAMETERS:

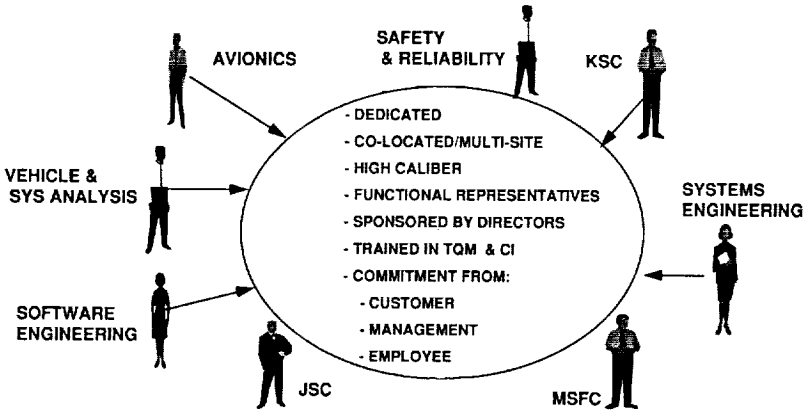
- LEVEL OF INVESTMENT
- EXPECTED COST SAVINGS



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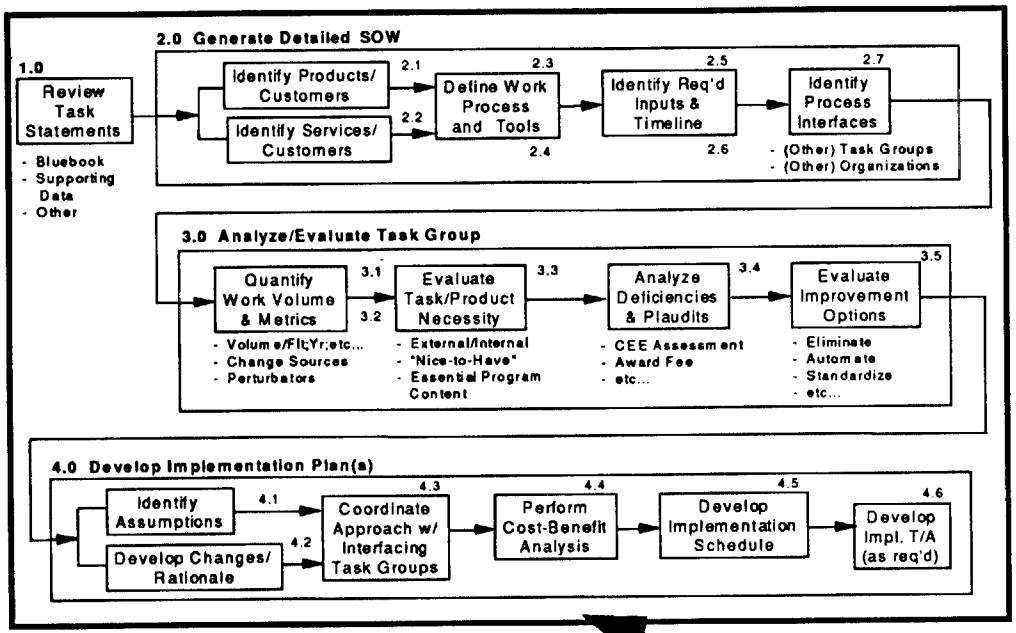
A Dedicated Cross-Functional Core Team Was Tasked To Identify Cost Effectiveness Enhancements (CEE)

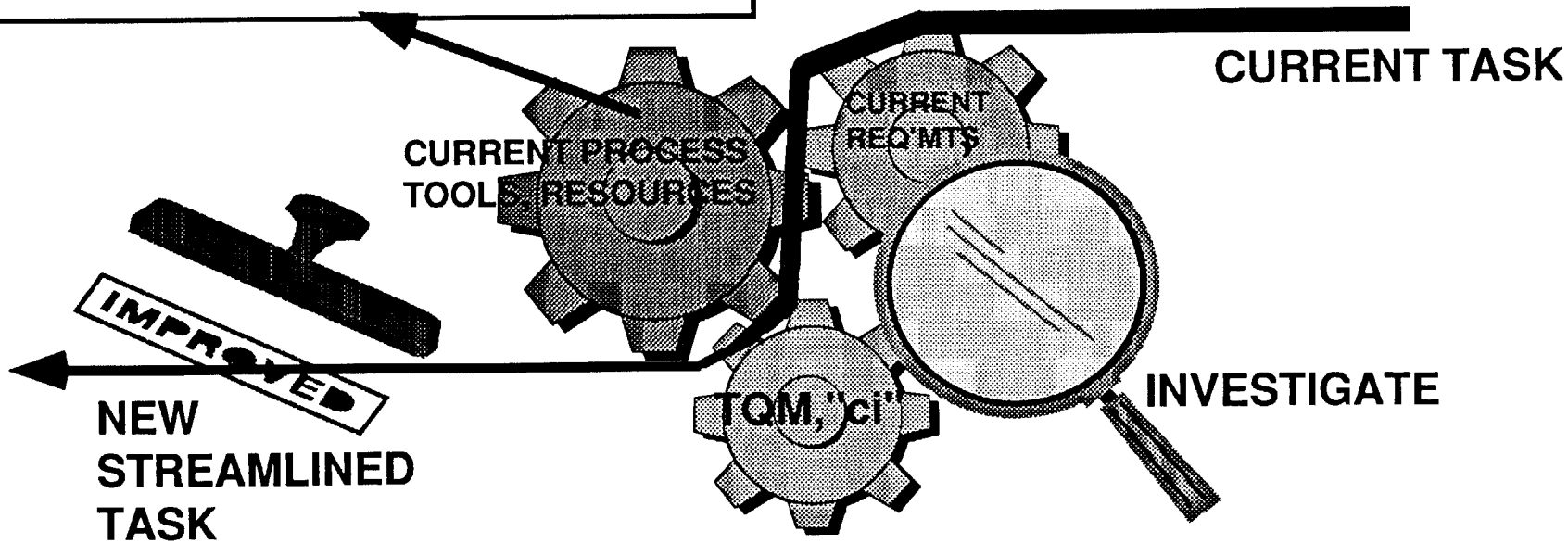


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The CEE Approach Emphasized Process Improvement (1)



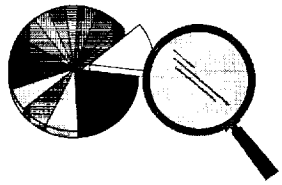


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The CEE Approach Emphasized Process Improvement (2)

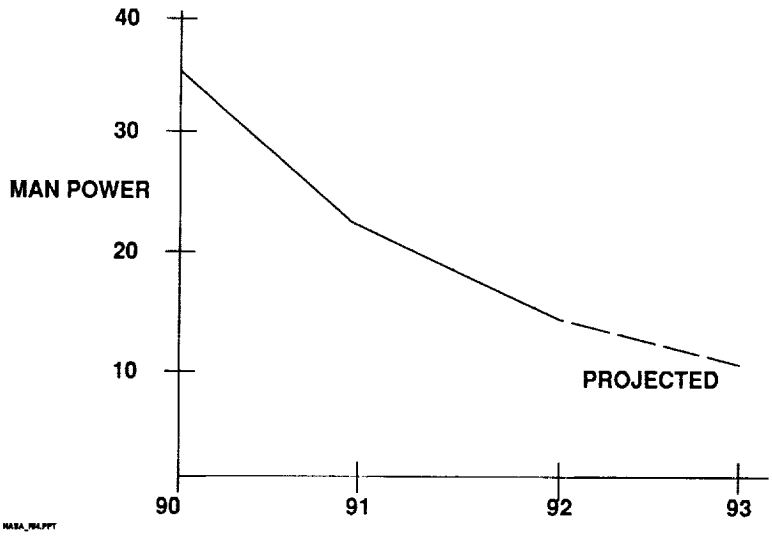
- GROUPED CONTRACT TASKS INTO SYNERGISTIC PIE SLICES
- REVIEWED CONTRACT WORK CONTENT AND PROCESSES
 - FORMED IMPROVEMENT TEAMS INVOLVING STAKEHOLDERS
 - CHALLENGED EXISTING PRODUCTS AND PROCESSES
 - APPLIED CONTINUOUS IMPROVEMENT AND TQM METHODS
- ELIMINATED LOW VALUE-ADDED WORK CONTENT
- NASA INVESTED IN IMPROVING PROCESSES FOR IDENTIFIED PAYBACK
- STREAMLINED AND AUTOMATED SEVERAL KEY PROCESSES



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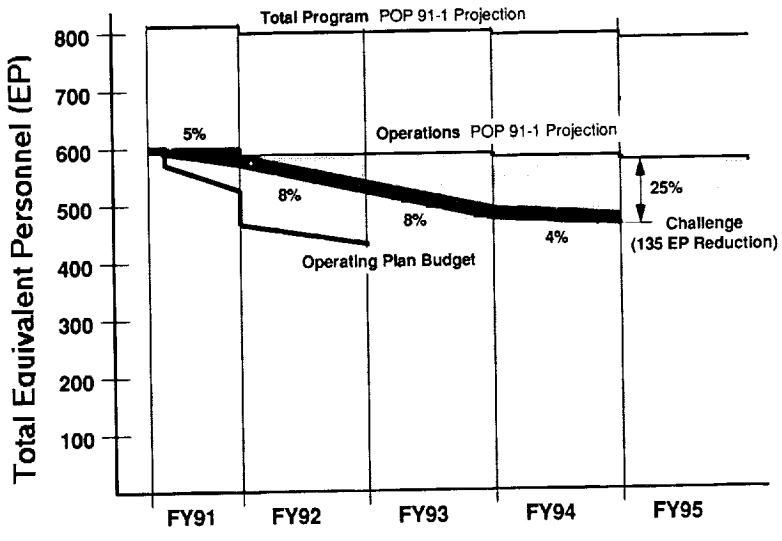
Flight Margins Assessment Task Was A Successful Example of The CEE Initiative



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Aggressive Pursuit Of The CEE Initiative Significantly Exceeded Initial Projections



Looking Back - Observations (1)

- WHAT WORKED?
 - WE WERE SUCCESSFUL IN ESTABLISHING COST EFFECTIVENESS AWARENESS ACROSS ALL LEVELS OF THE PROGRAM
 - WE HAVE GAINED TQM/QI EXPERIENCE AND CULTURE IN THE PROCESS
 - WE EXCEEDED OUR COST GOALS

Looking Back - Observations (2)

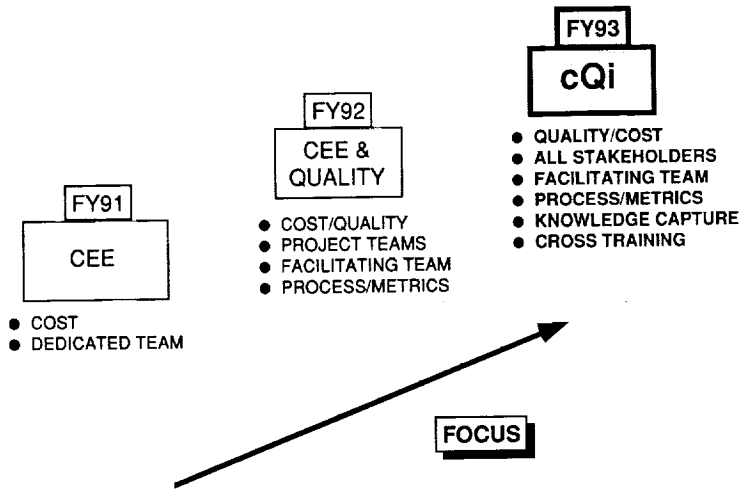
- WHAT DID NOT WORK?
 - CEE TEAM BECAME ISOLATED & ULTIMATELY PERCEIVED AS "OUTSIDERS"
 - DURING SECOND YEAR, CEE TEAM BECAME SELF-PERPETUATING ENTITY
 - RETENTION OF EMPLOYEES WAS UNSUCCESSFUL DUE TO EXTERNAL CIRCUMSTANCES
 - LIMITED NEW IDEAS
- WHAT WOULD WE DO DIFFERENT?
 - LIMIT TOP-DOWN APPROACH TO ONE YEAR
 - INITIATED A TQM/QI INITIATIVE EARLIER

In Summary:

- WIN-WIN PARTNERSHIP WITH CUSTOMER REQUIRED FOR SUCCESS
- OBTAIN COMMITMENT FROM MANAGEMENT AND STAFF
- COST EFFECTIVENESS FOCUS PRODUCES SIGNIFICANT RETURNS
 - ANNUAL GOALS EXCEEDED BY 100%
- "ci" IS AN INCREMENTAL PROCESS THAT REQUIRES STABILITY

THE SYSTEM INTEGRATION CONTRACT IS MOVING TOWARDS "CONTINUOUS QUALITY IMPROVEMENT"

The System Integration Contract Is Moving Towards "Continuous Quality Improvement"



omit

F3 Trust ----> Partners ----> Benefits (Continued)

This panel continues the subject started in Panel F2. There are many barriers to successful partnering such as conflicting goals, lack of trust, bureaucratic regulations, and protectionism by competitors. This panel will describe how these barriers were overcome.

Albert A. Strand, Director, Measurement and Computer Resource Center, and **Darryl J. Jackson**, Chief, Contract Management Division, Defense Plant Representative Office, TRW Electronic Systems Group, **"Teamwork for Oversight of Processes and Systems (TOPS)"**

Paul G. Tierney, Business Development Manager - NASA Programs, GE Aerospace, **"NASA/Contractor Partnership on Second TDRSS Ground Terminal - Breaking Barriers."**

Richard C. Tagler, Associate Director, Mission Operations and Data Systems, Goddard Space Flight Center, **"Government/Contractor Partnerships for Continuous Improvement: A Goddard Space Flight Center Example."**

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Teamwork for Oversight of Processes and Systems (TOPS)

Implementation Guide for TOPS
Version 2.0, 10 August 1992

N94-13167

Albert A. Strand, Director, Measurement and Computer Resource Center
TRW Electronic Systems Group

Darryl J. Jackson, Chief, Contract Management Division
Defense Plant Representative Office

F3.1-

1. Background

In the Spring of 1991, Defense Contract Management Command selected the Defense Plant Representative Office (DPRO) at TRW Space & Defense as one of seven organizations nationwide to develop and implement a Performance Based Management (PBM) Plan — a Total Quality Management (TQM) initiative. DPRO elected to develop the PBM Plan with TRW and to pursue it jointly. TRW and DPRO concurred on the Plan and mutually agreed on implementation.

2. Introduction

As the nation redefines priorities to deal with a rapidly changing world order, both government and industry require new approaches for oversight of management systems, particularly for high technology products. Declining defense budgets will lead to significant reductions in government contract management personnel. Concurrently, defense contractors are reducing administrative and overhead staffing to control costs. These combined pressures *require bold approaches* for the oversight of management systems.

In the Spring of 1991, the DPRO and TRW created a Process Action Team (PAT) to jointly prepare a Performance Based Management (PBM) system titled Teamwork for Oversight of Processes and Systems (TOPS). The primary goal is implementation of a performance based management system based on *objective* data to review critical TRW processes with an emphasis on continuous improvement. The processes are: Finance and Business Systems, Engineering and Manufacturing Systems, Quality Assurance, and Software Systems. The team established a number of goals.

- Delivery of quality products to contractual terms and conditions,
- Ensure that TRW management systems meet government guidance and good business practices,
- Use of objective data to measure critical processes,
- Elimination of wasteful/duplicative reviews and audits,
- Emphasis on teamwork — all efforts must be perceived to add value by both sides and decisions are made by consensus, and
- Synergy and the creation of a strong working trust between TRW and the DPRO.

TOPS permits the adjustment of oversight resources when conditions change or when TRW systems performance indicate either an increase or decrease in surveillance is appropriate. Monthly Contractor Performance Assessments (CPA) are derived from a summary of supporting system-level and process-level ratings obtained from *objective* process-level data. Tiered, objective, data-driven metrics are highly successful in achieving a cooperative and effective method of measuring performance.

The teamwork-based culture developed by TOPS proved an unequaled success in removing adversarial relationships and creating an atmosphere of continuous improvement in quality processes at TRW. The new working relationship does not decrease the responsibility or authority of the DPRO to ensure contract compliance and it permits both parties to work more effectively to improve total quality and reduce cost. By emphasizing teamwork in developing a stronger approach to efficient management of the defense industrial base TOPS is a singular success.

3. Responsibilities

TOPS consists of four main areas: Finance and Business Systems, Quality Assurance, Engineering and Manufacturing, and Software.

3.1 Finance and Business Systems

Finance and Business Systems covers the following TRW functions: contracts, pricing and cost data systems (estimating system), procurement, and property. Three of the systems, (pricing and cost data systems [estimating system], procurement, and property) require written certification by the Divisional Administrative Contracting Officer (DACO) that TRW policies and procedures satisfy all applicable laws, rules, and regulations of the government. The program applies to all TRW organizations in the Los Angeles area under DPRO cognizance.

3.1.1 TRW Functional Organization for Finance and Business Systems

3.1.1.1 Contracts

The contracts function participates in the sales acquisition process; serves as the official channel for business communications with the customer; conducts negotiations and commits TRW; determines contract requirements; and provides direction to company organizations regarding contractual compliance. Contracts also protects TRW financial, legal, ethical, and proprietary interests while promoting compliance with applicable laws and acquisition regulations.

3.1.1.2 Pricing and Cost Data Systems (Estimating System)

Pricing and Cost Data Systems provide financial leadership during the strategy, planning, development, and support of cost volumes. They strive to meet or exceed the needs of external and internal customers during cost estimating and pricing activities. Pricing and Cost Data Systems assures compliance with the Truth in Negotiations Act, the Estimating System Disclosure Statement, and all applicable laws and regulations. An element of the Estimating System is indirect and direct labor rate management activities. These functions are normally performed within the controller's organization of the applicable profit center.

3.1.1.3 Procurement (Subcontracts and Purchasing)

Sole authority for selecting sources; obtaining quotations; and awarding orders for materials, products, equipment, and services lies with Procurement, conducting these activities in the most economical and efficient manner. To accomplish this mission, purchasing serves as the official channel of communication to all suppliers; acts as negotiation agent of the company; and ensures compliance with all legal, ethical, administrative and documentation policies. Subcontracts manages acquisition from identification of need, to obtaining proposals or quotes, through final delivery and acceptance of systems, equipment, products, material, and services. They ensure compliance with all quality, reliability, technical, legal, and administrative requirements.

3.1.1.4 Property

A written Property control system provides for proper management and use of corporate assets and government property. Contracts require TRW to meet specific minimum requirements for the control, protection, preservation, and maintenance of all government property accountable to those contracts.

3.1.1.5 Critical Processes

Both TRW and the DPRO will review each functional system for the selection of "critical processes" for measurement. These reviews ensure compliance with government policy and verify efficient and effective operations. Some critical process measures reflect DPRO performance, such as the number of days it takes the DPRO to obtain a completed assist field pricing audit following a request from TRW. Criticality, impact, opportunity for improvement, and the ability to maintain regular surveillance will govern process selection. Following this review, TRW and the DPRO will agree on areas to measure. If a disagreement occurs, the DPRO position takes precedence. Addendum A lists current critical processes.

3.1.2 Finance and Business Systems Evaluation

To remove as much subjectivity as possible the performance of the critical processes will be measured with statistical process control (SPC) charts. The rating methodology of each critical process includes four key criteria: existence of process data (metrics), acceptability of the process, state of process control, and measurable improvement.

Existence of Data. The TRW process owner/evaluator has available an acceptable process performance metric and supporting data of the critical process.

Acceptability. Meeting statutory, regulatory, or contractual requirements. Processes whose output cannot be traced to statutory, regulatory, or contractual requirements will have their level of acceptability determined by the process owner/evaluator with the concurrences of the Finance and Business subteam.

Control. A measure of the deviations of the SPC data through the upper control level (and lower control level when appropriate for things such as rates), its variability, or trends that represent control of the process.

Improvement. The last eight data points show a positive trend, a reduction in variability, or have reached a level below which a further reduction would not be cost effective or meaningful (to be determined by the process owner/evaluator with the concurrences of the Finance and Business subteam).

Evaluators analyze the data collected on SPC charts and complete a rating of the four key processes with a point assignment as follows: 0 or 0.5 for existence of data and for improvement and 0, 0.5, 1.0, or 1.5 for acceptability and for control. Ratings of the critical processes in a functional area are weighted (if appropriate) and averaged to provide a monthly Contractor Performance Assessment (CPA). Ratings are prepared by the process owner/evaluator and presented with the SPC charts for concurrence at the monthly Finance and Business subteam meeting. The consolidated Finance and Business CPA is the average of the four functional CPAs.

3.2 Engineering and Manufacturing

3.2.1 Identification of Top-Level and Critical Processes

The Engineering and Manufacturing subteam based the identification of top-level and critical processes on the product development life cycle because it describes, in a generic manner, the steps a product goes through from conception to delivery. Process definitions fall into one of two categories: generic, top-level processes that make up the product development life cycle, or processes critical to a generic process that ensure an aspect of success. In the selection of top-level processes, TOPS uses brainstorming techniques and achieves consensus for each of the seven processes defined between concept definition and satellite delivery. They are: systems engineering, detailed design, subcontracts, parts procurement, manufacture, support equipment, and systems integration and test. Figure 1 shows a generic flow of the processes.

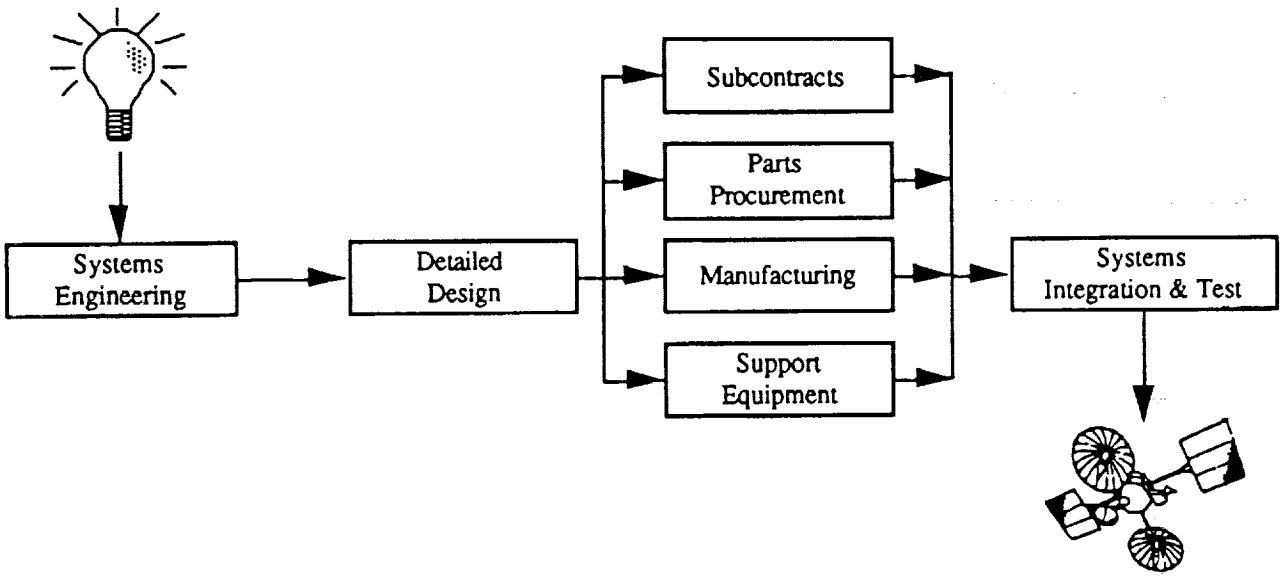


Figure 1. Generic Process Flow

The subteam chose critical processes from a high-level flowchart of each top-level process, as depicted in Figure 2.

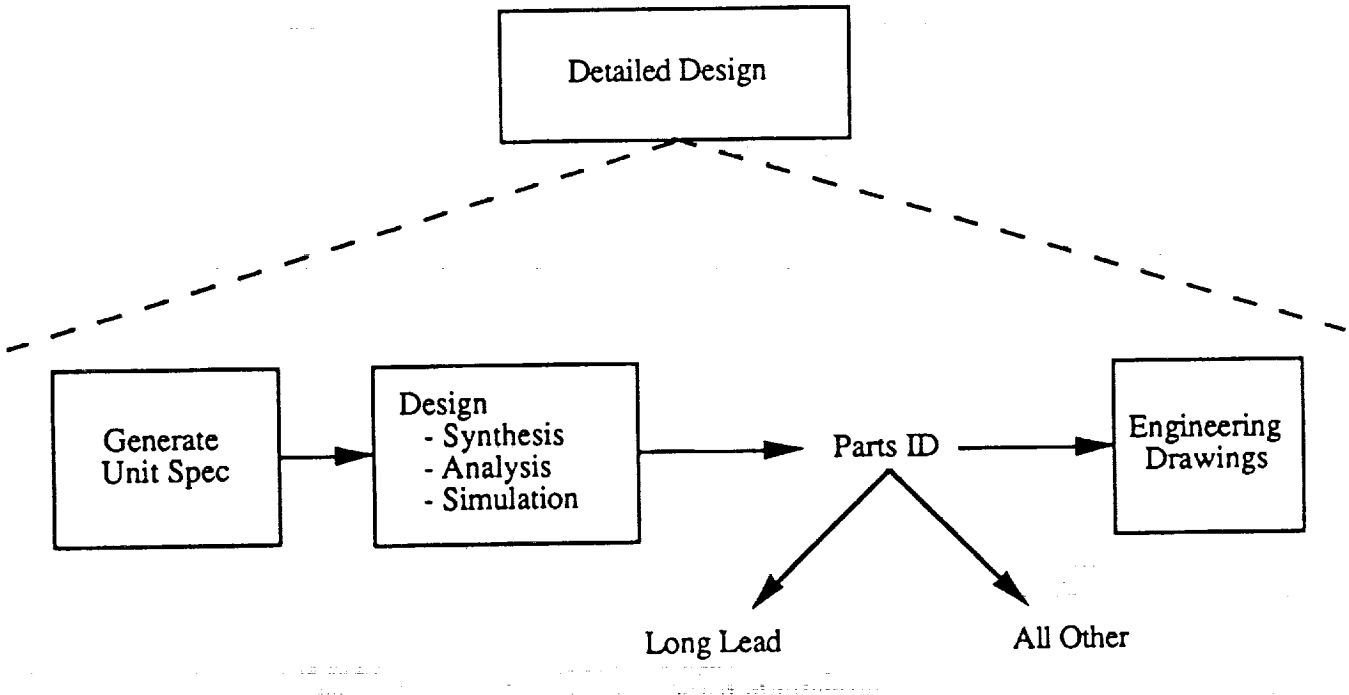


Figure 2. Top-Level Process Flow

To ensure correct selection of critical processes and to facilitate meaningful metric selection, the subteam completes a process schematic for each critical process. A process schematic defines the inputs, outputs, customer(s), customer expectations, quality expectations, and possible measurements (Figure 3). The document "Engineering & Manufacturing Subteam Process Package" contains high-level flowcharts for the top-level processes and process schematics for each critical process.

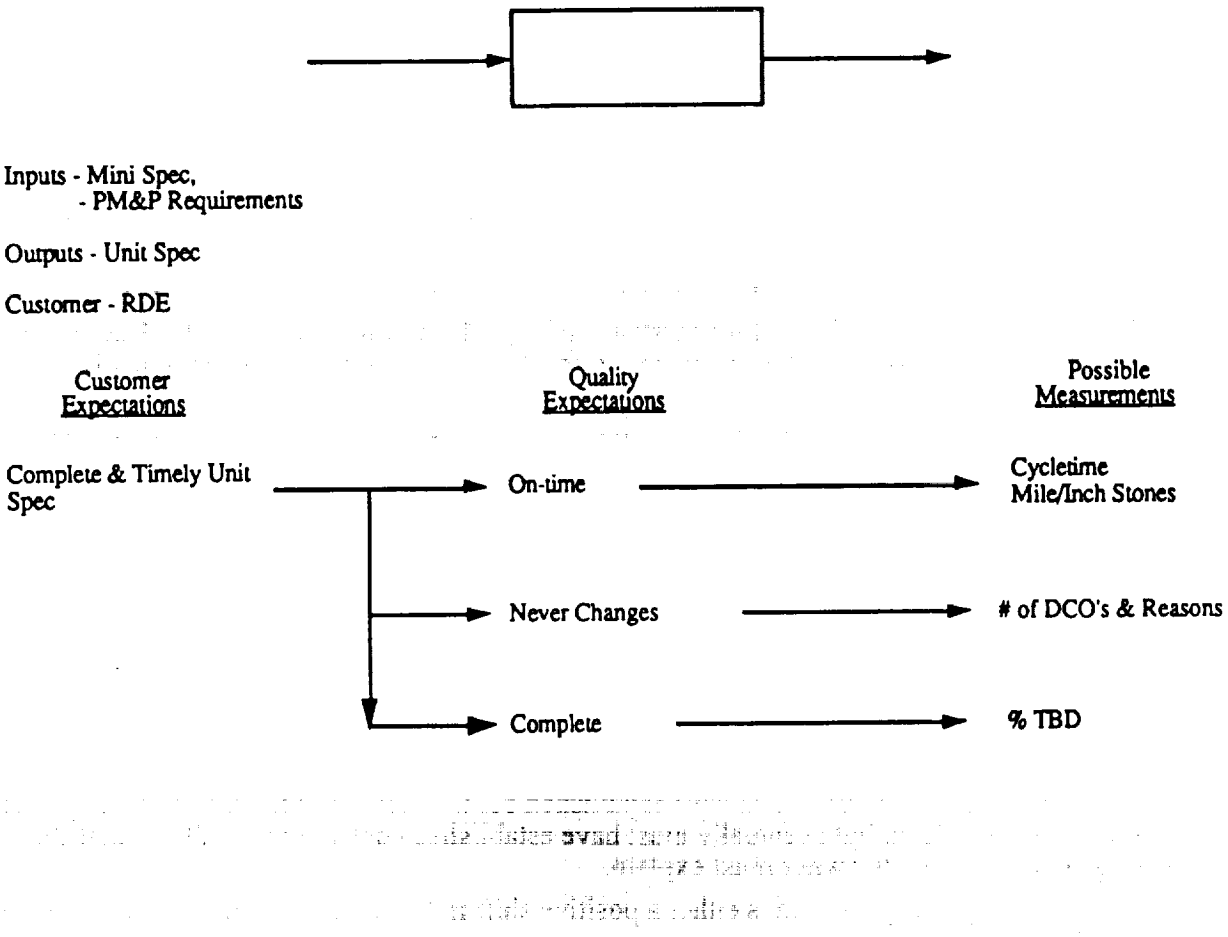


Figure 3. Unit Specification Generation Process

3.2.2 Identification of Process Performance Metrics

To remove as much subjectivity as possible from the rating scheme, the subteam, with the aid of the process owners, identifies process performance metrics (which characterize quality and cycle time) for each critical process, using the process schematic. The subteam avoids "reinventing the wheel" wherever possible using applicable metrics previously defined by TRW personnel in company TQM activities such as the Design Through Manufacturing (DTM) and Satellite Cost Reduction (SCORE) efforts. Defined metrics can and will change when new or superior metrics are established, or deleted if found to provide no added value.

3.2.3 Methods of Process Performance Analysis

To facilitate analysis statistical methods, preferably the use of SPC charts, will determine process trends; however, processes unsuitable for the application of SPC charts use other statistical means for interpreting data.

3.2.4 Methods Evaluation and Rating

3.2.4.1 Evaluation Criteria

To give both TRW and DPRO management a clear picture of the health of critical processes throughout TRW, the rating methodology embodies four key criteria: existence of process data (metrics), acceptability of the process, state of process control, and measurable improvement. Analysis of the collected metrics, plus other tangible and intangible information, determine point assignments. Where applicable, evaluators will normalize and analyze data via SPC charts, with point assignment as follows: 1 point for existence of data, 1 point for acceptability, 1 point for being in-control, and 1 point for improvement. Points for each critical process are equally distributed among the two categories of measurements (cycle time and quality). If there are multiple quality measurements, then points within the quality category are equally distributed, as well.

Key Term Descriptions:

Existence of Data. Initially, it is defined as performance metric(s) identified by the process owners and concurred by the subteam to be meaningful. The definition will change as the development of metrics mature.

Acceptability. 1) One or two performance metrics that measure a significant element of the process (such as span time, efficiency, or quality of the process). 2) Additional metrics must be developed and implemented in a reasonable time frame. 3) The absolute value of metric (for example, 100 EO's per drawing) is also considered as applicable.

In-Control. 1) The measured data have established control limits or are judged by the process owner to be in control, but eventually must have established control limits. 2) If variability swings widely, process owner must explain.

Improvement. A positive trend is either a positive shift in the process mean or a reduction in variability.

3.2.4.2 Evaluation Method

Evaluation teams evaluate and determine a grade for each critical/top-level process and give the result first to the process owner, then to the TOPS Engineering and Manufacturing subteam for incorporation into the overall group evaluation. The final grade, along with any necessary back-up documentation, goes to the DPRO Commander and the appropriate TRW Vice-President/General Manager (VP/GM) as part of the comprehensive TOPS rating. This structure pushes responsibility, accountability, and evaluation down to the level of work accomplishment. The

process owner knows the grade for his or her process(es) *before* the grade reaches upper management, enabling timely response preparation.

Figure 4 illustrates this method of process performance assessment.

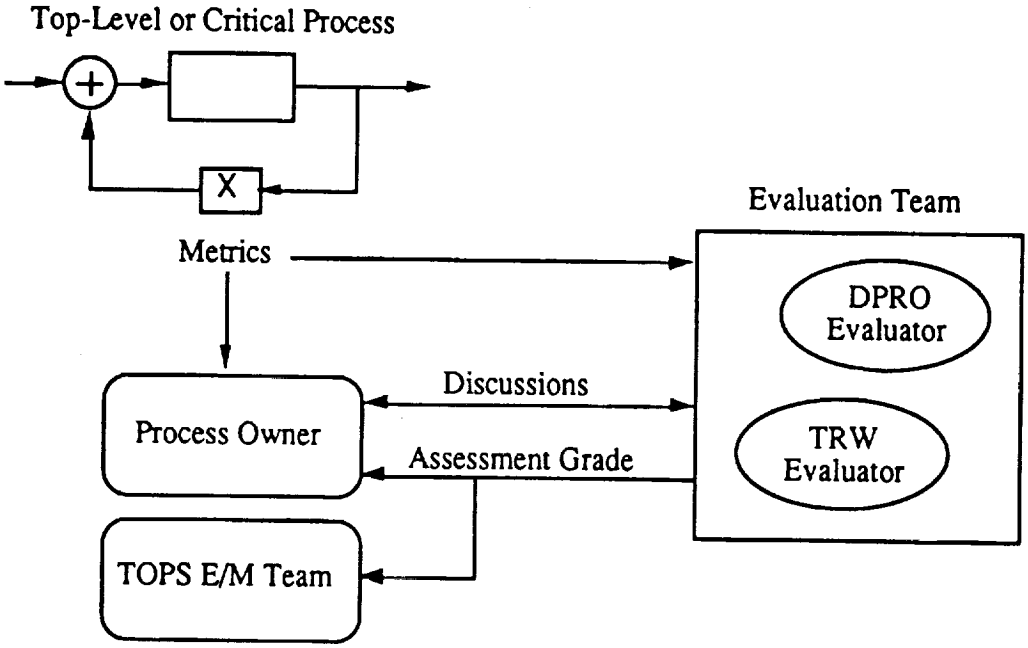


Figure 4. Top-Level or Critical Process Performance Assessment

Key Term Descriptions.

Assessment Grade. That grade determined from the evaluation criteria (see Section 3.2.4.1).

Discussions. Interactions with the process owner – interviews, investigations of out-of-control conditions, joint reviews, etc.

DPRO Evaluator. A DPRO employee knowledgeable of the TRW process.

Evaluation Team. A DPRO evaluator and a TRW evaluator who review the process performance metrics, discuss/investigate issues with the process owner, and determine an assessment grade.

Process Owner. The person responsible/accountable for process performance.

TRW Evaluator. A TRW employee knowledgeable of the process under evaluation and neither responsible for nor associated with the process performance.

Periodic evaluation of top-level and critical process occur as defined later in this guide.

3.3 Quality Assurance

Under TOPS, DPRO and TRW Space & Technology Group (S&TG) and Electronic Systems Group (ESG) will jointly review TRW quality systems and functions to support and facilitate the DPRO Quality Assurance (QA) Division's implementation of In-plant Quality Evaluation (IQUE). For Systems Integration Group (SIG) West, periodic audits are performed in lieu of TOPS surveillance. The DPRO/QA and TRW/QA group-level Major Support Processes (MSPs) are those key quality processes jointly identified by DPRO/QA and TRW/QA. Key subprocesses within each MSP are identified, flowcharted, and proofed, with measurement points selected or metrics developed for trending, analysis, and evaluation by the TOPS QA subcommittee and DPRO and TRW senior management. Management takes action as necessary to correct or to prevent undesirable trends or to address major deficiencies, problems, or concerns.

3.3.1 Responsibilities

As an integral part of the overall TOPS effort, a joint DPRO/TRW QA Steering Committee (TOPS QA subcommittee) meets regularly to direct and assure effective implementation of the TOPS QA efforts in support of the PBM initiative. This team will create and empower ad hoc working teams of DPRO/QA Operations Support Branch (RTQT) and TRW/QA personnel to analyze processes and data, to develop metrics and audit techniques, to work special problem areas, and to assist in implementation of the TOPS QA efforts. TOPS QA ratings, i.e., "TOPS-level metrics," will be prepared jointly and assessment reports made to DPRO and TRW management by the TOPS QA subcommittee. The TOPS QA subcommittee will evaluate the progress, problems, and lessons learned and redirect the overall effort as appropriate.

3.3.1.1 Mission Statement

Identify and define major support processes, emphasize the objective of continuous improvement, jointly, through consensus, develop objective criteria for an overall assessment method for measurement of the processes.

3.3.1.2 Goals and Objectives

a. Flow key quality processes and define associated value added metrics.
b. Reduce oversight through:
 (1) Achievement of confidence in key quality processes.
 (2) Institutionalizing process metrics for major support processes (MSPs).
 (3) Building trust between DPRO and TRW.
 (4) Conducting joint reviews.

3.3.2 Process Identification, Proofing, and Monitoring

3.3.2.1 Major Support Processes

Addendum C identifies the nine MSPs which describe the key quality processes. DPRO/QA and TRW/QA will use these MSPs to monitor the performance of TRW's quality system.

3.3.2.2 Process Selection

The TOPS QA team jointly selects the subprocesses in each MSP based on:

a. Identification by the Government and/or TRW.
b. Analysis of data which reflects opportunities for improvement.
c. Process(es) which represent the key quality systems.

3.3.2.3 Process Proofing and Monitoring

The ad hoc teams, appointed by the TOPS QA team, perform the following functions:

a. Flowchart the "as is" process(es).
b. Proof (validate) the process(es) against policy, procedures, and contract requirements.
c. Recommend metrics to measure the process(es).
d. Identify measurement points.
e. Perform process and/or product audits.
f. Collect, compile, review, trend, and analyze data and develop trend charts.
g. Use statistical process control (SPC) charts, as applicable.
h. Provide recommendations for process improvements.

3.3.2.4 Continuous Improvement Opportunities (CIOs)

Continuous Improvement Opportunities (CIOs) normally found when analyzing contractor data, conducting product audits, or proofing the adequacy of a process are submitted to the contractor. Implementation of CIOs by the contractor is optional. However, the contractor upon request by the government will provide feedback whether improvements were implemented or not. The TOPS QA team uses the standard format methods described below to issue CARs.

3.3.3 Standard Format Methods

3.3.3.1 Corrective Action Requests (CARs)

CARs consist of two types: verbal or written (Internal Compliance Review Reports [ICRRs]). Determination of which type to issue depends on the following factors: criticality of the nonconformance; frequency; effect on reliability, maintainability, or operability; whether the contractor has planned or taken corrective action (C/A); reluctance to initiate C/A; effectiveness (or lack thereof) of previous C/A; etc.

In all cases, DPRO/QA will: discuss the CAR with the responsible element(s) of both the contractor's performing organization and the TRW quality organization. Distribute written CARs (ICRRs) to the responsible discipline(s) and the quality organization. Enter all CARs (verbal and written) into a database. Verify adequacy of the C/A proposed, initiated, and implemented by the contractor, as evidenced by the absence or reduction of the defect in follow-on analysis of data or process/product audits. Record this verification in a log or record (manual or computer based).

3.3.3.2 Method C

Chronic or systemic process problems not addressed by the contractor typically indicates a failure to recognize that the problem exists. Normally, DPRO/QA issues a letter of concern requesting C/A. Inadequate C/A results in the issuance of a Method C. When serious quality problems exist and the contractor fails to take positive C/A, a letter forwarded to senior contractor management through the TRW DPRO Liaison Office will request immediate C/A for the observed deficiencies and their causes.

3.3.3.3 Method D

Where the contractor cannot or will not comply with contract requirements and C/A cannot be effected directly with the contractor by other methods, DPRO/QA personnel will request that the Administrative Contracting Officer (ACO) inform the contractor that all IQUE actions will be discontinued as required by Defense Logistics Manual DLAM 8105.1, "Contract Administration Manual for Contract Administration Services." This initiates Method D escalation. The ACO, in consultation with DPRO/QA personnel, determine the appropriate course of action. Government IQUE actions will totally discontinue only when authorized in writing by the ACO.

3.3.3.4 Method E

Where a subcontract is involved and the requirements for C/A are of the magnitude of a Method C or D, DPRO/QA will request that TRW take immediate C/A with the subcontractor.

3.3.4 Quality Assurance Evaluation

Each MSP rating uses the numerical application listed below, ranging from 0 (unsatisfactory) to 4 (exemplary).

4 = Exemplary
3 = Excellent
2 = Satisfactory
1 = Marginal
0 = Unsatisfactory

Each TRW group will be rated monthly by MSP (example below):

Systems	ESG	S&TG
QA1	4	3
QA2	3	3
QA3	4	3
QA5	4	3
QA6	4	3
QA7	4	4
QA8	4	4
QA9	3	3
QA10	3	3
TOTAL	**33**	**29**

Adding the 9 elements and dividing by the number of MSPs yields an overall numerical rating for each group. The accompanying descriptive rating comes from the following range chart.

Divide by 9 MSPs 3.6 (Excellent) 3.2 (Excellent)

0.0 - 0.5 = Unsatisfactory
0.6 - 1.5 = Marginal
1.6 - 2.5 = Satisfactory
2.6 - 3.5 = Excellent
3.6 - 4.0 = Exemplary

QA4 Software – Assessed by Software Process Improvement Initiative (SPII).

3.4 Software

The software subteam's goal is to develop a system for evaluation of the software development processes used at TRW. Once established, the system will be used as a base for continuous process improvement initiatives for TRW and for providing an objective measuring system for the DPRO. The system will identify the problem areas (or areas which could be improved) and provide the ability to detect improvements (or degradings) in the processes. The evaluation process is established by identifying metrics and then using continuous process improvement (in terms of the validity of the evaluation metrics) to continually improve the measurement system. Two divisions will be used to develop the first rating systems. These systems will be analyzed for similarities and used as a base for expanding surveillance to the rest of TRW. The similarities in the first two divisions and those in the rest of TRW should give some indicators as to the value of different metrics (i.e., identical metrics used throughout all the divisions shows a high value of the metric).

3.4.1 Scope

Software activities from all Space Park Divisions/Groups as well as the Division at Dominguez Hills will be included in these evaluations. At first, evaluations are limited to the SDD and SEDD divisions of the Systems Integration Group (SIG). The two divisions will be used in the development of evaluation processes and the descriptions contained herein are based on the similarities of the two divisions.

3.4.2 Structure

The overall TOPS software evaluation has three components: 1) the underlying process capability (20% of the grade), 2) the effectiveness of management's implementation of the processes (40% of the grade), and 3) the ultimate performance of the processes (40% of the grade). These components along with "Key Process Areas" are shown in Figure 5.

The process capability component of the evaluation is based on four processes. The first depends on meeting the maturity improvement goals of the Software Engineering Institute's (SEI) Capability Maturity Model (CMM). The SEI was set up by the government (because of the increasing life cycle importance of software) to identify and solve problems with software acquisition. The CMM provides as a baseline to evaluate the contractors ability to produce the required software product within all the procuring agency's constraints. The second and third processes involve the use of technology (i.e., introduction and dissemination) within an organization. The fourth process for the capability evaluation is based on TQM/CPI practices.

The management component of the evaluation examines management oversight, project metrics, and feedback from the customer. The weightings assigned to each of these categories varies depending on the division and/or group. The management oversight entails C/SCSC, CSSR, or some other type (if used) of cost/schedule reporting. Project metrics will vary from division (or group) to division (or group). Some examples of these are number of source lines of code (SLOCs) design and built versus the number planned to be built, number of SLOCs turned over (for test) versus the number of SLOCs planned to be turned over, and number of capabilities integrated verses number of capabilities planned to be integrated. The actual metrics used depends on the division/group as well as the definitions of the measurable quantities.

The performance component of the evaluation is based on a combination of DPRO and TRW quality data. DPRO data is comprised of IQUE activities (e.g., SDF code inspection. The SDF code inspections are a metric which identifies the number of SDFs evaluated for coding versus SDFs found with code nonconformances.) TRW data is comprised of various contractor evaluations/functions conducted by program level QA (contractual) and independent management level (system) evaluations. Two types of findings are generated during these reviews — internal corrective actions that require formal review and correction and noted recommendations identified to the project by the review team.

3.4.3 Review Methodology

For the software process:

- Senior management within a TRW surveillance area identifies functional points of contact (engineering, quality assurance, program management, etc.).
- These personnel work with the identified DPRO members to establish a joint team to identify, prioritize, and implement the processes for surveillance.

The team shall:

- Identify the data which will be collected.
- Collect and report on the agreed upon data.
- Verify the collected data is correct.
- Interview cognizant personnel, as required.
- Review documentation, as required (i.e., UDFs, SDFs, etc.)
- Establish and update the rating (and reporting) system, as required.
- Identify, evaluate, and implement (as required) capability improvements to the rating (and reporting) process.
- Identify, evaluate, and implement (as required) capability improvements to the software development processes.

Figure 5 illustrates this structure:

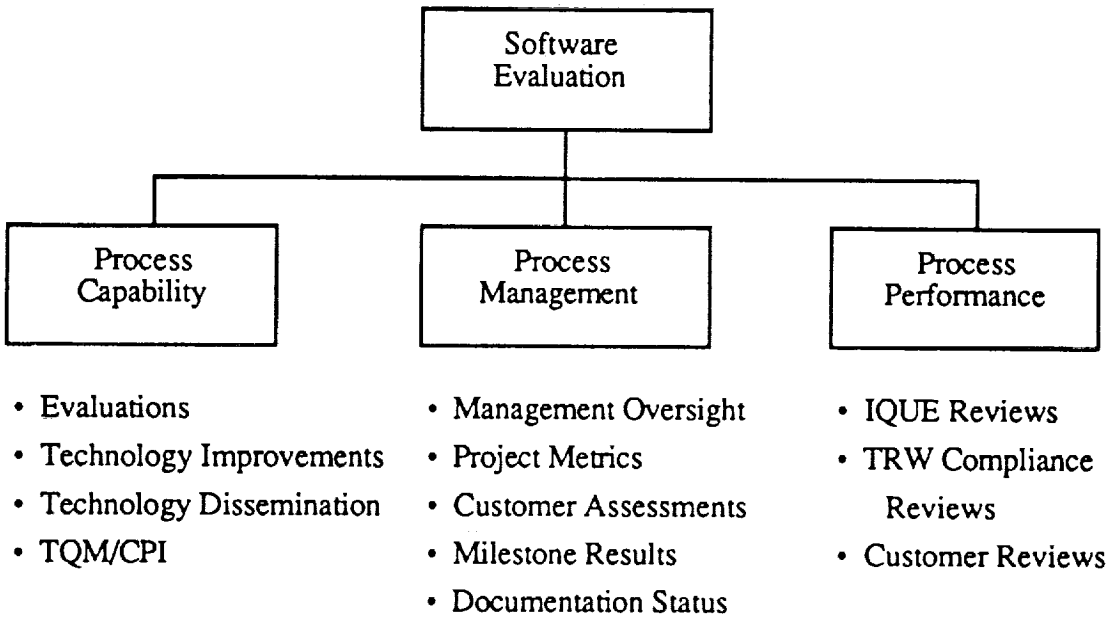


Figure 5. TOPS Software Evaluation Components

4. TOPS Evaluation

Figure 6 presents the flow of rating data within the DPRO and TRW. Each functional subteam must supply data based on a five point scale for review by TOPS management at a monthly meeting. The lead DPRO representative of each subteam will present the consolidated process ratings as an overall group rating (see Figure 7 for a sample group-level assessment chart). Additionally, the subteam leader must present back-up data, as appropriate, for concerns that the subteam wishes to elevate. Also at the monthly meetings, DPRO and TRW management will review and discuss the results of joint or independent evaluations and any other pertinent information, including TRW TQM activities. Finally, discussions would cover potential problem resolutions and recommended courses of action. These could run from continued problem monitoring, to establishing a process action team (joint or independent), to a letter from the DPRO to correct the problem. When the DPRO notifies TRW in writing of a problem, the notification should go to the TRW DPRO Liaison Office to ensure proper distribution and coordination within TRW. Figure 8 presents the corrective action matrix, depicting the methods of notification and escalation for each subteam.

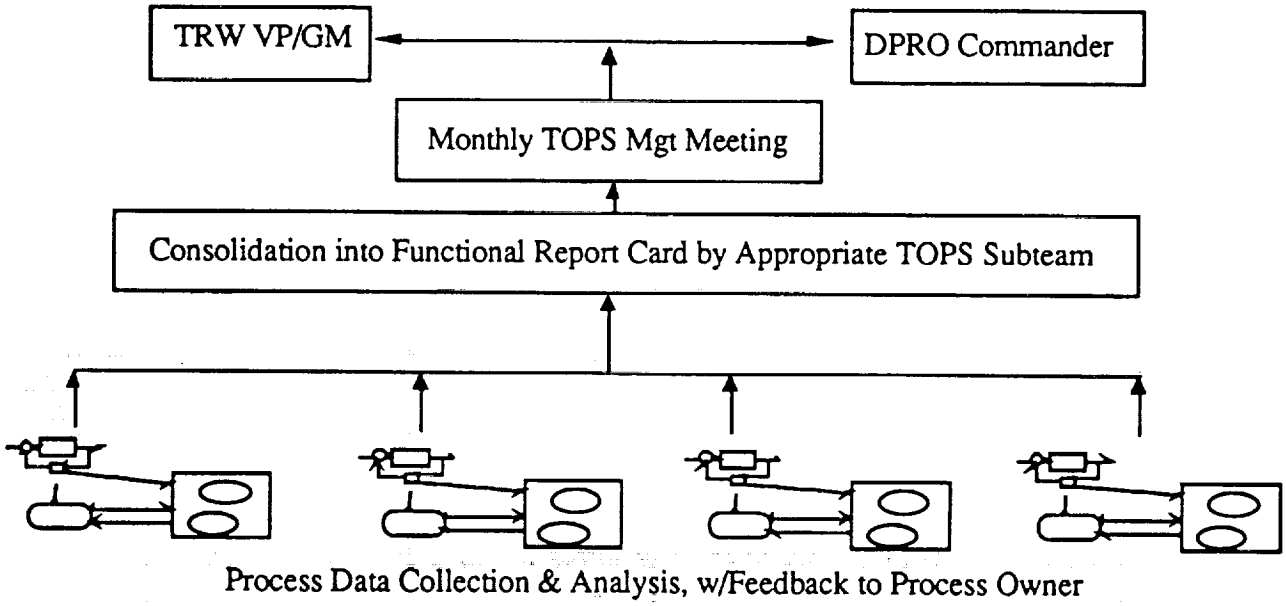


Figure 6. Management/Rating Assessment Structure

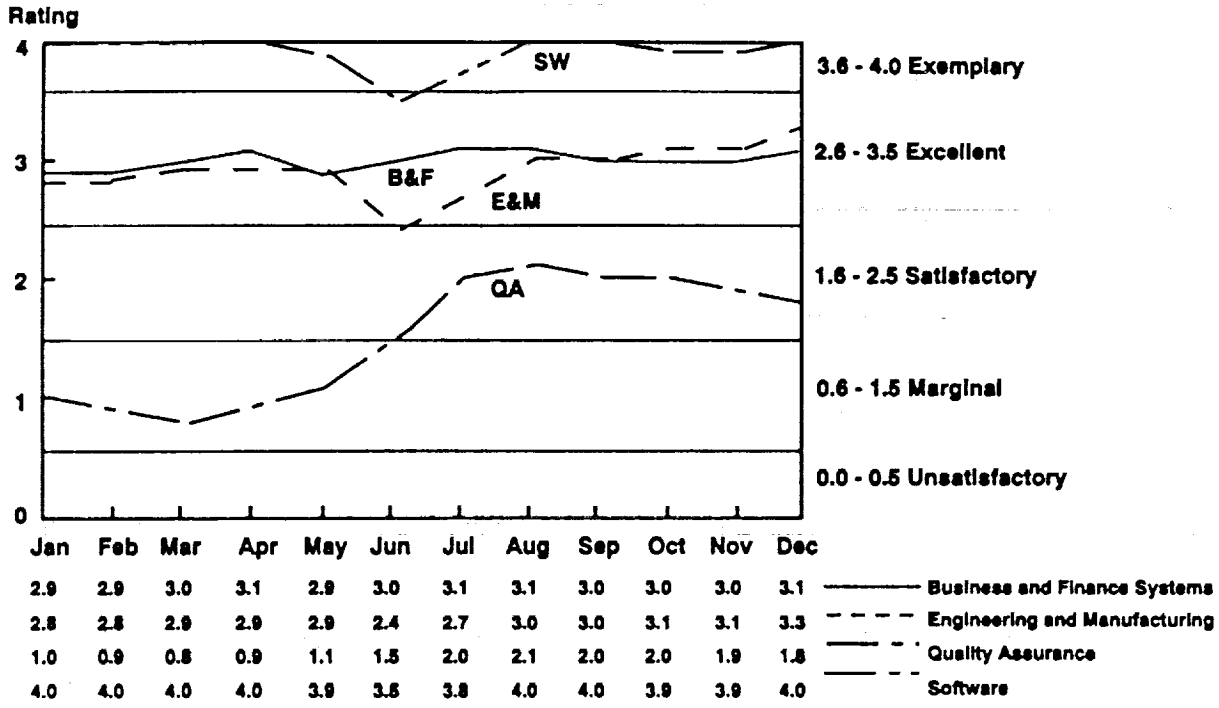


Figure 7. TOPS Monthly Assessment (Sample Data)

Notification and Escalation

Functions	Level 1 Continuous Improvement Opportunities (Non Contractual)	Level 2 Minor Non-Conformance (Contractual)	Level 3 Systemic/Process Non-Conformance (Contractual)	Level 4 Systemic/Process Failure (Contractual)	Level 5 Failure to Take Timely and Effective Corrective Action (Contractual)	Level 5a Supplier/ Subcontractor Non-Conformance (Contractual)
Commander	Continuous Improvement Opportunities (CIO) letter	Not applicable	Not applicable	Use formal letter addressing major concerns or problems	Letter addressing the fact that corrective action not timely and/or effective	Not applicable
Finance and Business	Continuous Improvement Opportunities (CIO) letter	Verbal or written letter addressing areas of concern	Letter from Division Chief requesting corrective action plan addressing problem or concern	Letter of notice of intent to disallow progress payments from DACO	Execution of notice of intent to withhold/ disallow progress payments from DACO	Not applicable
Engineering and Manufacturing	Continuous Improvement Opportunities (CIO) letter	Letter from evaluator addressing areas of concern	Letter from Division Chief requesting corrective action plan addressing problem or concern	Letter from Division Chief to group general manager requesting corrective action plan addressing problem or concern	Letter from Commander addressing the fact that corrective action not timely and/or effective	Not applicable
Quality Assurance	Continuous Improvement Opportunities (CIO) letter	Verbals (daily log entries)	• ICRRs (Internal Compliance Review Reports)	• Method C Letter to TRW from the Quality Division Chief or the Commander	Method D Letter from ACO based on recommendations from Commander/ Quality Division Chief for discontinuation of IQUE	• Method E Letter addressing a problem or concern at a TRW supplier/ subcontractor
Software	Continuous Improvement Opportunities (CIO) letter	Verbals (daily log entries)	• ICRRs (Internal Compliance Review Reports)	Letter from Division Chief to group general manager requesting corrective action plan addressing problem or concern	Letter from Commander addressing the fact that corrective action not timely and/or effective	Not applicable

Figure 8. TOPS Corrective Action Matrix

5. Acronyms

ACO	Administrative Contracting Officer
AFMC	Air Force Material Command
APMA	Automated Property Movement Authorization
BOE	Basis of Estimate
C/A	Corrective Action
CACO	Corporate Administrative Contracting Officer
CAR	Corrective Action Request
CAS	Contract Administration Service
CCN	Contract Change Notice
CER	Cost Estimating Relationship
CIO	Contractor Improvement Opportunity
CPAR	Contractor Performance Assessment Report
CPI	Continuous Process Improvement
CPSR	Contractor Purchasing Systems Review
CSE	Contractor System Element
DACO	Division Administrative Contracting Officer
DCAA	Defense Contract Audit Agency
DCMC	Defense Contract Management Command
DCMDW	Defense Contract Management District West
DFAR	DOD supplement to the FAR
DLA	Defense Logistics Agency
DLAM	DLA Manual
DOD	Department of Defense
DPRO	Defense Plant Representative Office
DTM	Design through Manufacturing
ESG	TRW Electronic Systems Group
FAR	Federal Acquisition Regulation
GAO	General Accounting Office
I&T	Integration & Test
ICRR	Internal Compliance Review Report
IG	Inspector General
IQUE	In-Plant Quality Evaluation
LAN	Local Area Network
MGI	Mandatory Government Inspection
MOA	Memorandum of Agreement
MSP	Major Support Process
NASA	National Aeronautics and Space Administration
ODC	Other Direct Cost
OFPP	Office of Federal Procurement Policy
OMB	Office of Management & Budget
P&TS	Program & Technical Support
PAT	Process Action Team
PBM	Performance Based Management
PCO	Procuring Contracting Officer
PO	Purchase Order
PR	Purchase Requisition
PROCM	Procurement Manual
QA	Quality Assurance
R&D	Research & Development
RFP	Request for Proposal
ROAE	Return on Assets Employed
S&D	TRW Space & Defense Sector

S&TG	TRW Space & Technology Group
SCORE	Satellite Cost Reduction
SEC	Securities & Exchange Commission
SIG	TRW Systems Integration Group
SOW	Statement of Work
SPC	Statistical Process Control
SPII	Software Process Improvement Initiative
TBD	To Be Determined
TINA	Truth in Negotiations Act
TOPS	Teamwork for Oversight of Processes and System
TQM	Total Quality Management

6. Addenda

A. Finance and Business Systems

A.1 Critical Process Oversight

The DPRO and TRW jointly selected as critical processes those processes essential to DPRO's oversight responsibilities and operational effectiveness. Compilation of specific data by TRW will facilitate oversight of the critical processes and provide the DPRO with tangible evidence of the effectiveness of these processes. DPRO may also select and gather data on some critical processes to assess their own performance, e.g., the number of days required for the DPRO to obtain a completed field pricing audit report per a TRW request. The DPRO will use statistical process control (SPC) charts to assess these processes. SPC charts will be prepared such that situations or occurrences that would be deemed to be "out of tolerance" by the DPRO will be easily identifiable, so the measurement of the number of such occurrences is clear and indisputable.

A.2 Critical Processes

A.2.1 Contracts

A.2.1.1 Contract Closeout

After contract completion, when the product and/or service is delivered to and accepted by the customer, a specific closeout process is conducted. Before TRW submits a final invoice to the customer, several internal closeout actions are completed as specified in Contracts Manual section 501, "Closeout of Cost Type Contracts." On completion of these actions, a final invoice, release, and assignment are prepared. For this critical process, the time intervals identified below will be tracked and measured. The source of the data points will be the Contract Closeout Status Report CM071EM published by the Contract Information Center. The data tracks the time interval between the date the contract entered into closeout and the date all closeout actions are completed. The time interval between the date the final invoice is submitted to the DPRO and the date payment is received from the paying office is also tracked..

A.2.1.2 Restrictive Markings Notification

Contracts manual bulletin number 16 requires that the contract administrator to provide written notification to the contracting officer within 60 days after award of the name and title of the person having final responsibility for determining whether restrictive markings are to be placed on technical data to be delivered under the contract. In order to monitor TRW's compliance with this clause, we will track the time interval between the date of contract award and the date restrictive markings notification is submitted by the contract administrator.

A.2.1.3 Waivers and Deviations

When project management determines that a need exists to request a waiver to or deviation from contractual specifications, the waiver/deviation is prepared in a manner suitable for government review and approval. Waivers and deviations are granted by the cognizant government contracting officer. For this critical process, the following time intervals will be tracked and measured. The time interval between the date the waiver or deviation was submitted and the date the approval or denial was received from the DPRO/customer.

A.2.1.4 Progress Payments

Progress payments will be tracked from the time they are prepared by Accounting Operations, delivered to the DPRO or DCAA, as appropriate, and returned to Accounting Operations after approval by the cognizant government office.

A.2.1.5 Invoices

Invoices will be tracked from the time they are prepared by Accounting Operations, delivered to the DPRO or DCAA, as appropriate, and returned to Accounting Operations after approval by the cognizant government office.

A.2.1.6 Cost Accounting Standards Disclosure Statements

The Cost Accounting Standards (CAS) require TRW to submit disclosure statements regarding its accounting practices. These disclosure statements are amended each time a change in cost accounting practices occurs. TRW must submit amendments to the government 60 days prior to their effective date. As a process essential to the government's oversight responsibility, TOPS will measure the adequacy and timeliness of TRW's CAS disclosure statement modifications.

A.2.2 Pricing and Cost Data System (Estimating System)

Six processes have been identified as critical in the Pricing and Cost Data System (Estimating System) area. The primary areas of focus were identified as part of the joint DCAA, DPRO, and TRW Proposal Process Action Team (PAT), and the recently completed Estimating System Survey conducted by DCAA and the DPRO. In addition the DACO must submit written certification that the TRW Estimating System satisfies all applicable laws, rules, and regulations of the government. To ensure that the estimating system requirements are continually met, six critical processes will be monitored monthly against control limits established in each area. Those critical processes are listed below.

A.2.2.1 Cost Estimating Relationship (CER)

CERs are used within proposals for elements that are estimated in relationship to another element, i.e., ODC as a percent of labor dollars. CERs will be monitored to ensure that the actuals incurred are within the control limits established in the CER methodology and therefore remain valid CERs.

A.2.2.2 Basis of Estimate (BOE)

A BOE contains the estimating methodology for a proposed task including the documentation of the logic used, i.e., the historical costs referenced and justification for differences. The results of the joint proposal review checklist questions regarding BOEs will be monitored against the control limits established as quality measures.

A.2.2.3 Material

Material includes electrical, mechanical, and engineering purchased parts and raw material used in the fabrication of hardware. The results of the joint proposal review checklist questions regarding material will be monitored against the control limits established as quality measures.

A.2.2.4 Subcontract Analysis

Subcontract analysis is performed on all major subcontracted products or services that are in excess of $500,000 to determine that the price is fair and reasonable. The results of the joint proposal review checklist questions regarding subcontract analysis will be monitored against the control limits established as quality measures.

A.2.2.5 Assist Field Pricing Audit Reports

Assist field pricing is performed by DCAA when a prospective subcontractor denies TRW access to their books and records. The average number of days to obtain completed Assist Field Pricing Audit Reports will be monitored against established control limits.

A.2.2.6 Other Direct Cost (ODC)

ODCs includes accounts for items used in support of program activities, i.e., travel, repro, and computing. The results of the joint proposal review checklist questions regarding material will be monitored against the control limits established as quality measure.

A.2.2.7 Direct Labor Rates

Direct labor rates will be tracked and compared to the negotiated rates on a composite basis. As long as the rates remain within the established tolerances, no additional effort is required by either TRW or the DPRO staff.

A.2.2.8 Indirect Rates

Indirect rates will be tracked and compared to the negotiated rates for the major indirect cost pools on a quarterly basis. As long as the rates remain within the established parameters, no additional effort is required by either TRW or the DPRO staff. Should the rates fall outside the tolerance range, TRW will provide additional support/explanation in order to assist the DPRO in their determination as to whether an adjustment to billing is appropriate.

A.2.3 Procurement (Subcontracts and Purchasing)

Four critical processes have been jointly identified by the DPRO and TRW. The monitoring of these processes will be facilitated by specific metric data displayed on SPC charts prepared by TRW. SPC charts will be prepared to identify both "out of control" as well as normal operations. The "out of control" condition, if any, will be clear and indisputable and the results of any corrective action will be readily visible. The four critical processes area are shown below.

A.2.3.1 Advance Notice and Prior Consent

Customer advance notification or prior consent (or both) may be required from TRW customers prior to TRW awarding a procurement contract. The TRW Consolidated Prime Contract Summary (CPCS) lists those procurements which require advance notification or prior consent (or both). The Procurement Analysis and Review (PAR) will determine, if required, that the procurement package has the advance notice or prior consent (or both) and that it was done in compliance with the applicable procedures. If there is an omission it will be noted for internal improvement purposes and included in the SPC chart for that month. Any correction will be made prior to package approval. In addition, an annual random sample of all procurement packages will be conducted to ensure all completed packages have satisfied the requirement for an advance notice or prior consent (or both). The number of discrepancies found by the PAR will determine if adequate instructions or additional training are necessary.

A.2.3.2 Price and Cost Analysis

Proposals and quotations obtained in support of potential POs/SCs (or changes thereto) require certified cost or pricing data whenever the proposal exceeds the dollar threshold established by public law or whenever it is required by the terms and conditions of the TRW customer contract and do not meet the exceptions to the requirements for certified cost or pricing data. The PAR will determine, if required, that the procurement package has the required price or cost data and that it was done in compliance with the applicable procedures. If there is an omission or discrepancy it will be noted for internal improvement purposes and included in the SPC chart for that month. Any correction will be made prior to package approval. In addition, an annual random sample of all procurement packages will be conducted to ensure all completed packages have satisfied the requirement for cost and pricing data. The number of omissions or discrepancies found by the PAR will determine if adequate instructions or additional training are necessary.

A.2.3.3 Small/Small Disadvantaged Business Concerns

Quarterly reports are submitted to the DPRO concerning TRW's achievements on meeting goals established for Small/Small Disadvantaged Business Concerns (S/SDBCs), Historically Black Colleges and Universities (HBCU), and Minority Institutions (MI).

A.2.3.4 Certification

Certifications are required by public law and the Defense Acquisition Regulation/Federal Acquisition Regulation (DAR/FAR) under specified conditions in TRW procurement packages. These certifications involve such things as Equal Opportunity in Employment, the Clean Air Act, The Federal Water Pollution Control Act, and related regulations of the Environmental Protection Agency (EPA). The PAR will determine if the required certifications are included and correctly filled out. If there is an omission or discrepancy it will be noted and included in the SPC chart for that month. Any correction will be made prior to package approval. In addition, an annual random sample of all procurement packages will be conducted to ensure all required certifications are included and correctly filled out. the number of omissions or discrepancies found by the PAR will determine if adequate instructions or additional training are necessary.

A.2.4 Property

The Government Property Administrator is required to perform an annual survey that reviews TRW's compliance with its property control procedures. The government's guidelines for conducting the reviews were used. Under the FAR provisions if several property system criteria are met, the annual survey requirement can be changed to a biennial audit requirement. Therefore to meet the FAR criteria for biennial survey review, the government audit guidance for reviewing the TRW property control system was used to select jointly seven processes which are essential to the DPRO oversight responsibilities. Those seven processes are shown below.

A.2.4.1 Acquisition of Equipment

The acquisition of special test equipment requires government approval in advance of the acquisition unless identified in the contract. This evaluation criteria will measure the acquisition for equipment and the compliance with the advance notice and approval request to the government. Purchase requisitions will be reviewed for inclusion of end use codes, the proper cost account codes, and the advance government approval to acquire. The matrices will be purchase requisitions reviewed and with correctly completed criteria.

A.2.4.2 Movement of Equipment

Location of equipment is an important aspect of inventory control of assets. The Automated Property Movement Authorization (APMA) is a document created in the records computer database which provides for the hard copy movement document and electronic location changes in the records. This evaluation criteria will evaluate the timeliness of the closure of the movement documents and location updates for equipment moves. The APMAs will be reviewed for the timeliness to complete (close) the APMA; this action updates the location changes of equipment. The matrices will be the number of open APMAs exceeding "x" days for each group.

A.2.4.3 Physical Inventory

Physical inventories of *material* not only fulfill a contract requirement, but also is important to ensure that parts and assemblies received into the storerooms remain available to meet the production schedule and contract delivery requirements. This evaluation criteria will measure the annual schedule and the actual performance against that schedule. The material physical inventories are completed annually and performed throughout the year. The matrices will be 1) a measure of actual performance against the planned schedule, and 2) a measure of the variances between the records balance-on-hand and the actual count of each item.

The physical inventory of *equipment* can be extended to longer periods than material because of several reasons. Equipment has a longer life span. There is less turnover of equipment than material, and material is purchased closer to its usage date. However, it is still important to verify that equipment items are available. The evaluation criteria will measure the physical inventory schedule and performance to that schedule. The physical inventory of equipment is on a biennial basis occurring in the odd number years. The matrices will be 1) the measure of the actual performance against the planned schedule, and 2) a measure of the variances between the records and the actual count of the equipment items on a contract basis.

A.2.4.4 Use of Equipment

Equipment is acquired to support a development or production task or a test requirement under contract. These equipment items are retained do to their use; and when no longer required, they become excess to that contract. When excess, the items should be legalized on another contract or disposed of. This evaluation criteria will evaluate current and projected use for the items. As a result of a TQM/CPI effort, all equipment will be coded for its utilization and retention requirements. The matrices will be timeliness in completing this semiannual task and quantity of equipment in each of the six retention code categories.

A.2.4.5 Equipment Maintenance

Government equipment must be properly maintained to provide for maximum life and correct performance. The criteria for maintenance involve both the determination of need for maintenance and, where appropriate, the performance of maintenance. Maintenance may include any of the following: inspection (evaluation), operator performed (functional), electronic or mechanical repair (corrective), or routine periodic (preventative). Based on the application of the equipment, calibration may be required. The custodian may elect to have designated equipment maintained by virtue of calibration being performed by a centralized calibration organization. The evaluation criteria for maintenance will measure the actual performed maintenance against the custodian's determination of need for said maintenance.

A.2.4.6 Contract Property Closure

The process to ensure proper disposal of all government property accountable to a contract is generally one of the last tasks to be completed prior to contract closure. This evaluation criteria will evaluate the completion of all tasks required to issue a property closeout certification. The process of property contract closure is an extended task that can often delay the contract closeout activity. This process requires focused attention and reporting. The matrices will be the time period from initiation of contract closeout until the property certification is issued.

B. Engineering and Manufacturing

B.1 Critical Processes

These defined critical process are still generic in nature and each critical process will be further defined by product line or cost center code.

B.1.1 Systems Engineering

B.1.1.1 Concept Design

Determines generic system elements and the manner in which those elements will satisfy functional requirements.

B.1.1.2 Requirements Allocation

Defines the performance requirements needed for each system element to attain the overall performance requirements of the system.

B.1.2 Detailed Design

B.1.2.1 Unit Specification Generation

Defines discrete unit level requirements, derived from the mini specification flow down from systems engineering.

B.1.2.2 Design

Determines the manner in which the unit will be designed to satisfy the unit specification engineering and M&P.

B.1.2.3 Engineering Drawing

Transfers conceptual drawings and schematics to detailed drawings used to build the design.

B.1.3 Parts Procurement

B.1.3.1 Specification Generation

Takes the parts identified from design and program quality requirements and determines the specifications needed for said parts.

B.1.3.2 Purchase Order (PR to PO)

Purchases a specified part from a list of possible vendors.

B.1.3.3 Supplier

The vendor builds the part to specification.

B.1.3.4 Receipt to Issue

Receiving of the parts and parts data, performing V&H testing if required, and delivering those parts to their respective customers.

B.1.4 Subcontracts

The subcontracts process is very similar to the parts procurement process in that two of its three defined critical processes are the same, spec generation and supplier. The order placement process is different from the purchase order process in that it involves the establishment of a subcontract that usually requires some developmental work by the subcontractor.

B.1.5 Manufacturing

B.1.5.1 Fabrication

Transforms raw materials into some desired output.

B.1.5.2 Assembly

Assembles piece parts into some desirable unit.

B.1.5.3 Test

To test either functionally, visually, or dimensionally, the fabricated or assembled part to determine if it meets specifications.

B.1.6 Support Equipment

The support equipment process is a microcosm of the top-level processes. The critical processes defined are: mini-spec generation, electrical design, product design, fabrication and assembly, and integration and test. The mini-spec generation process takes an equipment spec and test requirements and generates a test set mini-spec. The electrical design process takes the test set mini-spec and identifies parts and new processes, schematics, conceptual drawings, interface drawings, and rack layouts. The product design process takes the schematics, identified processes, parts list, and mini-spec and transforms those into a completed engineering drawing. The fabrication and assembly process manufactures the subassemblies and assemblies. Finally the integration and test process integrates and tests the subassemblies into a completed piece of support equipment.

B.1.7 Systems Integration and Test

Assembly, integration, and test of various boxes into a satellite ready for launch.

B.1.7.1 Requirements Definition

Transforming systems engineering requirements into a test requirements document.

B.1.7.2 Procedure Definition

Taking the requirements documents and developing a detailed assembly and test procedure.

B.1.7.3 Assembly

Takes hardware, software, and detailed test procedures and assembles a satellite.

B.1.7.4 Integration

Takes the assembled systems and tests it to determine if requirements are being met.

B.1.7.5 Acceptance Test

The process of testing a fully assembled and integrated satellite to determine if the system is ready for launch.

B.2 Metrics Identification

Critical Processes	Metrics
Systems Engineering	• Time between program start and release of unit specs • Actual time required to release unit specs vs. planned time
Detailed Design	• Number of engineering changes per drawing • Deviation of total design hours from standard • Number of first pass successes in design
Subcontracts	• % of letter subcontracts • Average days to definitize • % of subcontracts with late deliveries • Delivery schedule of subcontracts • Integration rejects as a % of subcontracts • Nonconforming material as a % of subcontracts • Preventable notices as a % of subcontracts
Parts Acquisition	• Number of notice of delay of material per lot • Number of procurement deficiency reports per lot • Material acquisition time in weeks
Support Equipment	• Design hours per released drawing • Fabrication and assembly hours per unit • Design hours per gate • Design hours per unit • Number of deliverable source instructions developed per hour • Design errors per released drawing • Avoidable rework per assembly hour
Systems Integration and Test	• Integration returns • Time lost vs. time worked
Manufacturing	• Engineering caused rework as a % of bench hours for fabrication/assembly and test • Manufacturing caused rework • Other types of rework • Number of nonconforming materials • Number of test discrepancy reports

C. Quality Assurance

The authority and responsibility for managing the contractor's quality program should be complete, properly assigned, and documented using written policies, procedures and work instructions. The following major support processes (MSPs) should be addressed as part of the contractor's quality system.

C.1 QA Internal Audits/Training and Quality Cost (QA-1)

The quality organization must:

- Assign authority and responsibilities to organizations performing quality functions.
- Establish a training and certification program.
- Have an internal audit system.
- Have provisions for collection and use of quality cost data.

C.2 QA Planning/Work Instructions (QA-2)

The contractor's planning program should provide for timely and effective planning, which has:

- Methods for accomplishment of comprehensive contract reviews.
- Provisions for inspection and test planning during the earliest practical phase of contract performance.
- Methods for verifying that inspection and test planning is compatible with manufacturing methods, processes, drawing requirements and inspection instructions.

C.3 Records (QA-3)

The contractor's quality system is to assure that records are kept current, complete, legible, and accurate during all phases of design, development, manufacturing, test, etc., as a means of maintaining the continuous history of the product/service, e.g., fabrication and assembly history; build-up and disassembly, repairs, rework, results, configuration data, etc.

C.4 Software QA (QA-4)

This MSP will be assessed by Software Process Improvement Initiative (SPII).

C.5 Nonconforming Supplies (QA-5) (TRW, Suppliers, and Subcontractors)

The Quality organization must assure:

- Effectiveness authorized PR/MRB dispositions.
- Timeliness of dispositions.
- Provide methods for the positive identification, segregation and storage of nonconforming supplies in adequate holding areas.

C.6 Corrective Action (QA-6) (TRW and Suppliers)

The contractor's corrective action program should provide for the timely detection of discrepancies and ensure timely and positive action is taken to eliminate the cause of defects. The corrective action system should include requirements for:

- Effectiveness of completed corrective action (recurrence).
- Timeliness of corrective actions.
- Effectiveness of Supplier and Subcontractor Corrective Action(s).

C.7 Supplier QA (QA-7) (Suppliers and Subcontractors)

The contractor's quality program should ensure that all supplies and services purchased from suppliers conform to contractual requirements. The effectiveness and integrity of quality control and corrective action by suppliers should be assessed and reviewed by the contractor. The contractor's quality program should:

- Ensure that products are inspected on receipt to determine acceptability.
- Have objective evidence data to be used for adjusting the extent of receiving inspections.
- Provide for an effective vendor rating system.
- Ensure that untested product and raw material are identified and segregated from those tested and accepted.
- Provide for functional tests to be performed to the required specification, technical order, drawing or contract, if testing is required.
- Ensure that suppliers' quality systems meet the quality requirements of the subcontract/purchase order (flowdown of QA requirements).

C.8 Metrology, Calibration, and Tooling (QA-8)

The contractor's quality program should provide for an effective metrology and calibration system, for standards and measuring test equipment. The contractor's quality program should:

- Ensure that required certified measurement standards as well as gauges, testing, and measurement equipment are available and used.
- Ensure testing and measuring equipment, including personally-owned tools when authorized, to be recalibrated on a regular basis to determine that they are of required accuracy.
- Maintain records for the control of calibration activities.
- Ensure that calibrated measuring and test equipment have evidence of traceability either through primary or reference standards to the National Institute of Standards and Technology or natural physical constants.
- Ensure that environmentally controlled areas are maintained.
- Ensure that when measuring and test equipment becomes damaged or inaccurate they be effectively controlled, replaced, or repaired.
- Ensure that tooling used as a media of inspection is calibrated or certified, and proven for accuracy before use and reinspected at established intervals which ensures the adjustment, replacement, or repair of the tooling which becomes inaccurate.

C.9 Materials, Treatments, and Processes (QA-9)

The contractor's quality program should provide for monitoring materials, treatments, and processes such as soldering, welding, heat treating, etching, plating, and promptly correcting improper process monitoring methods or inspection and test techniques. This includes:

- Adequacy of materials storage and usage and proper nondestructive inspection controls.
- Contractor personnel should monitor special controls for age sensitive items such as chemicals, rubber lubricants, paints, and adhesives.
- Material should be protected against deterioration, damage, contamination, or electrostatic discharge damage in use or in storage.
- The contractor should have provisions for assuring the control of processing environment, as well as the necessary degree of certification, inspection, authorization on and monitoring, for such specialized processes.

C.10 Inspection and Test (QA-10)

The contractor's quality program should ensure final inspection and test of products are performed by quality personnel. Such inspection and testing will provide a measure of the overall quality of the completed product. Testing will be performed so that it stimulates to a sufficient degree, product end use function.

D. Software

D.1 Software Process Capability

The ability of the contractor to establish, maintain, and improve a software development infrastructure capable of fulfilling contractual cost, schedule, and technical constraints.

D.1.1 SEI CMM-Based Evaluations

D.1.1.1 Assessment Results
D.1.1.2 Evaluation Results

D.1.2 Technology Improvements

D.1.3 Technology Dissemination

D.1.4 TQM/CPI Activities

D.2 Software Process Management

The ability of contractor management to development and implement a plan to produce quality software within contractual cost, schedule, and technical constraints.

D.2.1 Management Oversight

D.2.1.1 Cost Variance
D.2.1.2 Schedule Variance

D.2.2 Project Metrics

D.2.2.1 Software Development Status
D.2.2.2 Software Capabilities Integrated
D.2.2.3 Requirements Verification
D.2.2.4 Software Problem Reports

D.2.3 Customer Assessments

D.2.3.1 Award Fees
D.2.3.2 Other Assessments

D.2.4 Milestone Results

D.2.5 CDRL Submittal

D.3 Software Process Performance

The evaluation of the quality and the cost, schedule, and technical impacts of the contractor's software development process.

D.3.1 IQUE Reviews

D.3.2 TRW Compliance Reviews

D.3.3 Customer Compliance Reviews

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NASA/Contractor Partnership on the Second TDRSS Ground Terminal Program - Breaking Barriers

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In December of 1988, NASA awarded a contract to GE Aerospace for development of the Second TDRSS Ground Terminal, a major addition to NASA's Space Network. This ground terminal was planned to enhance availability of user service by providing a backup to the existing White Sands Ground Terminal and to provide the additional capacity needed to support the growing needs of the '90s.

This paper briefly introduces the STGT Program from its technical and programmatic backgrounds and then describes several techniques to enhance communication and empower the NASA Contractor team. A major factor in our success was an approach we used to shorten the time span of the Critical Design Review phase. This approach is described. The relationships involving NASA's O&M contractor are discussed. The paper concludes with a set of lessons learned.

STGT Description

Figure 1 shows the architecture of the Space Network including the Second TDRSS Ground Terminal. The purpose of the network is to relay data from satellites in low earth orbit to the scientific users and manned flight controllers for such missions as the Space Transportation System, Hubble Space Telescope and in the not-too-distant future, Space Station Freedom. The Network is scheduled by the Network Control Center at the Goddard Space Flight Center and ultimately relays mission data to and from the various Project Operation Centers. The relay satellites are in geosynchronous orbits providing ready access to user satellites. The currently existing White Sands Ground Terminal is located in Las Cruces, New Mexico, just west of the San Augustine mountains. The Second TDRSS Ground Terminal is being installed and tested in a 85,000 square foot facility, three miles north of the existing terminal. In the final configuration the two stations share operations of the relay satellites and provide the needed capacity for user service.

Programmatic Background

STGT is a very robust architecture with a highly distributed design, automated switching to redundant equipment, and sophisticated signal processing. Technically challenging, STGT is also being developed to an aggressive schedule. These factors combine with a large number of contributors to the program. We at GE had over 500

people at the peak point of the program as well as 15 large subcontracts. NASA Goddard, as the customer, is supported by a System Engineering contractor and the contractors who operate the existing White Sands Terminal and who will operate STGT following achievement of Initial Operational Capability in January 1994. These ingredients demand frequent and tight communications to meet the challenges of this development program.

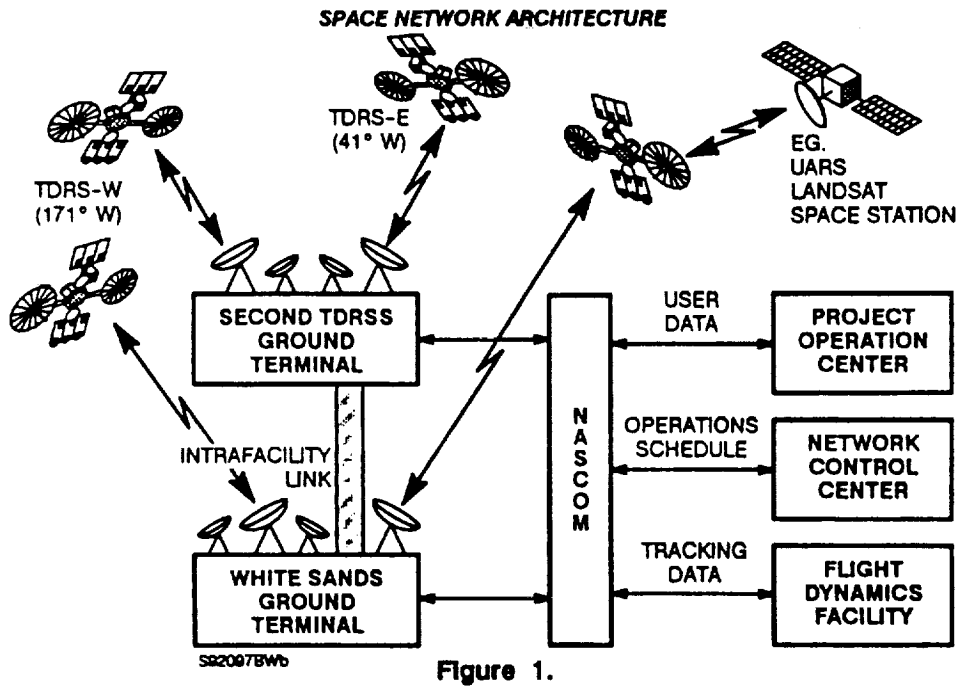


Figure 1.

Enhanced Communication on STGT

We began our development for STGT with two broad concepts for communication. First, we (NASA and GE) began by holding progress reviews on a six week cycle. After a few sessions, we established a format for these that everyone was comfortable with. We had one or two days of detailed technical sessions and then a full day, program level review, during which we addressed all key areas. One criterion we established early was that these sessions were open to all program participants; NASA Headquarters as well as our direct customer at Goddard, NASA's associate contractors and our own subcontractors. We decided that for a team to work effectively all the participants should be hearing the same data at the same time. With the exception of financial data, we ran these meetings, and the entire program in fact, as an open book.

On a day to day basis we also insisted on open communications among all participants at all levels. Both NASA and GE put out lists of personnel showing their areas of responsibility and phone numbers. This was definitely unstructured and was not constrained by points of contact or rigid manager to manager interaction. It was not anarchy either. There were a number of natural NASA-Contractor relationships which provided a beneficial degree of channeling. One observable of wide open

communication is the speed with which "hot" news, especially bad news travels. There are some who want to be the first to fill in the boss on a juicy tid-bit and sometimes that can get the system agitated. On balance, it produces positive results. If a real problem is surfacing, it gets attention quickly. If it's a red herring, the rumor gets squashed just as quickly.

Two kinds of video conferencing were used as tools in our open style. One is the more typical video room with the capability of several cameras and wide band transmission to include slides and video tape. The second tool was a desk top system that can be thought of as a picture phone. They are small desk top units that connected my office directly with the NASA Project Manager for literally, face-to-face phone conversation. Both of these techniques worked well saving much travel time and money. On the other hand, old habits die hard; the desire (and need) for some face-to-face, in-person contact remains.

Enabling the Team

While the flow of meetings and the use of video conferencing may be indicative of open communications, there were two specific areas that exemplify the philosophy. As in all managed organizations, NASA ran a weekly staff meeting. Staff meetings can frequently be the forum where private data is discussed or where the restricted participation creates an "us against them" mindset. The NASA staff meetings were viewed as just another team function. NASA's support contractors and GE participated fully thereby emphasizing the team feeling.

GE for its part provided open access to project data, schedules, milestones, and discrepancy reports to name some specifics. What's more, most of this was computerized, so we granted access to NASA and to their support contractors to our computerized data files. All individuals were treated the same way in terms of being granted logon identifiers and passwords. The key observation here is that once a user is in the system, he or she can browse in other areas of information. In order to grant access in this broad way requires trust, trust that people are working together to meet common goals. The attitude that is created is a very positive one and a very powerful one.

Compressed Design Reviews

In the Critical Design Phase of the development, GE was planning for a series of design reviews with each of our subcontractors. Our first thought was to review each subcontractor's work ourselves and then to summarize the process for our customer, NASA, in a subsequent review. When we laid out a detailed plan, we found that we needed to fit 55 design reviews into a six month window and if each review meant two meetings, one with the subcontractor and one with NASA, that over 100 meetings would

be needed in the six month period. We concluded that was not practical. Having been operating under an open communication philosophy, the obvious idea surfaced; let all the reviewers sit down one time and do the design review once. That was the plan we adopted. Yes, there were risks. Suppose a particular design area was weak. Would NASA criticize GE for not staying in control of the subcontractor? How would we react when NASA tried to direct our subcontractors? We came up with lots of frightening scenarios but at the bottom line, we had no choice. Time was too short to conduct all the reviews in a way that would control all the data and discussion and also meet the schedule. Raising all these issues explicitly helped us formulate the detailed, do-it-once, plan of attack. The result was we met the very demanding schedule for the Critical Design Review. We had excellent synergy in the review team since GE, NASA, and NASA's associate contractors were all represented. Finally we all kept our relationships in focus so that subcontractors got their direction from GE; we in turn worked with our customer, NASA. We clearly took some risk in this approach, but our team trust and open discussion won the day.

NASA Operations and Maintenance Approach

The plan for STGT is for a GE development followed by operations and maintenance of the station by NASA and their O&M contractor. NASA has separate contractual relationships with the O&M personnel as an integral part of the development approach. Today there are about 50 O&M personnel in residence at our facility in suburban Philadelphia. They receive formal training and they also receive hands-on experience with the hardware and software as we are developing it. The O&M contractor personnel provide operational insight to our GE developers as well as direct assistance in a number of development tasks. One barrier that has been surmounted is the fact that we have competitors in our development facility. This creates an instinctive reluctance to work together. Here again, we took a very pragmatic approach and did all we could to ensure success. We feel that all the Government's objectives have been met. Their O&M contractor personnel are becoming well trained and experienced and GE has benefited from the operational expertise and direct labor support.

Lessons Learned

All efforts to instill a sense of teamwork and open communication worked with some making a larger contribution than others. All of our joint meetings and reviews, whether live or via video conferencing, worked very well. The single pass design review process made an impossible task possible. In my experience in this area a few themes rise to the surface:

1. In dealing with open communication and people's natural desire to be the bearer of good (or bad) news, it is possible for the same news item in several sets of words to race around your program community, what I would term an information race

condition. When this happens, a little patience is required to sort out the sometimes conflicting versions and get down to the real issue.

2. There will be times when constraints are needed and communications must be focused through points of contact. This can happen when the organization is running at a high level of stress because of an impending deadline or some crisis. On STGT, this also came about because of how we were organized. NASA had a functional structure (e.g., hardware or software) while GE was more product focused. This led to situations where a single contractor person spent their time in open communications with many individuals at the temporary penalty of their responsibilities being compromised. Generally, these spells ended quickly and were self-healing.

3. Open communication, teamwork, and authority can all be consistent if everyone is aware that the prime contractor works for the government and the subcontractors have their responsibility to the prime.

4. As in sports, each player has to trust all of the other team members. When all one's energy can be focused on winning and no energy is sapped on wondering "what if he....." or "suppose she.....", then partnership and full team work develop. At this level the team is not guaranteed a victory but the team will play the game to its fullest potential.

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Government/Contractor Partnerships for Continuous Improvement

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A Goddard Space Flight Center Example

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ABSTRACT

This paper discusses the efforts of a government organization and its major contractors to foster a continuous improvement environment which transcends the traditional government/ contractor relationship. This relationship is aimed at communication, partnership, and trust -- creating benefits for all involved.

1.0 Introduction

Continuous Improvement (CI) activities on an informal basis have been an integral part of the Goddard Space Flight Center's Mission and Data Operations Directorate (MO&DSD) for many years. These efforts derived from our employees' desire for technical excellence, an ever-increasing demand for quality services from our users, and the necessity for improved productivity in the face of decreasing budgets.

In 1991, concurrent with the Center's pilot application for the President's Award for Quality and Productivity and the subsequent evaluation by the NASA wide review team, these improvement efforts were formalized and a CI program was established.

In a September 1991 message to Center senior management, Center director Dr. John M. Klineberg stated that "the Center's strategy for excellence is to improve continuously the Center's products, services, and work processes now is the time for us to formalize our processes to undertake this mission." Coinciding with this message was the publication of the GSFC Strategic Plan, which set Center-wide goals and strategies for excellence and continuous improvement.

As Associate Director of the MO&DSD and Technical Officer for the directorate's two major contracts, the author began generating interest in CI in early 1991 by establishing informal meetings with management and representatives from each contract. The group, known as TQM.500, brainstormed ideas, exchanged experiences, and identified potential advocates ("quality champions") within the divisions. Within a short period of time, additional government employees joined the group.

The major groups represented by TQM.500 are:

a. The MO&DSD civil servant organization (650 employees).

b. The Network and Mission Operations Support (NMOS) contract, held by the Bendix Field Engineering Corporation (BFEC) (2,300 employees).

c. The Systems, Engineering, and Analysis Support (SEAS) contract, held by the Computer Sciences Corporation (CSC) (1,500 employees).

The government/contractor organizational structure will be discussed in paragraph 1.1.

1.1 Background

The Mission and Data Operations Directorate is one of nine directorates that comprise the Goddard Space Flight Center in Greenbelt, Maryland. The MO&DSD's ten divisions and offices are responsible for developing and operating mission operations and data systems. The MO&DSD provides telemetry, command, tracking, data acquisition, data processing, and communications support services for low-earth orbiting spacecraft missions and for GSFC flight projects that require major data system support.

In 1987, the MO&DSD combined nine support contracts into two major 10-year contracts: SEAS, the systems development contract, managed by CSC; and NMOS, the operations and maintenance contract, managed by Bendix. These two contractors, and their associated subcontractors, provide the main support to the directorate.

Both the NMOS and SEAS contractors had a long history of service at GSFC, and both had active CI (or TQM) programs. The NMOS TQ activities evolved from its Productivity Improvement and Quality Enhancement (PIQE) program that had received two Goddard Excellence Awards, the U.S. Senate Productivity Award for Maryland, and three-time finalist status for the George M. Low Trophy/NASA Excellence Award.

SEAS was actively involved in a very ambitious TQM program that featured full training and participation of its workforce and improvement initiatives on all of its many tasks.

The NMOS and SEAS organizations essentially mirror the MO&DSD structure. This structure is shown in Figure 1, which also shows additional support areas necessary to accomplish MO&DSD's missions. The two contracts interface with the government at all technical levels. Within each division, there is a separate Assistant Technical Officer for NMOS and SEAS.

The author is Technical Officer and Performance Evaluation Board (PEB) Chairman for NMOS and SEAS. These roles give him a broad view of the business and technical aspects of

each contract, and allow rapid access to both Program Managers and their resources and expertise.

Of major concern, besides meeting the cost, performance, and schedule objectives of these contracts, is the smooth transition of newly developed systems into the operational environment with good teamwork between the government and each contractor and between the two prime contractors. It was this concern that fostered the continuous improvement partnerships among all of these elements.

GSFC also began to foster continuous improvement awareness at the Center through symposiums and communication of TQ information. The Center Director established a team to recommend the direction the center should take in the CI effort. Another team led by NASA Headquarters evaluated the NASA centers to provide a baseline from which to start. This evaluation was baselined against the Presidential Award criteria.

The MO&DSD used the assessment to begin the first steps in providing TQM awareness, its attributes, and potential benefits. Champions were identified, various government and industry activities were observed, and a number of teams were started within the directorate. TQM goals were established in performance plans and the foundation for CI was started.

The Center Director also established a TQ Working Group, made up of senior managers from all of the directorates and major contractors. The author serves as a member of this group, which is leading the effort toward implementation of CI throughout the Center.

1.2 Objectives

TQM.500 was formed to stimulate learning and idea sharing, and to create an effective partnership (win-win) environment. Both of the contractors involved came into the group with some CI and TQM experiences, and these experiences were used as the basis for identifying issues and challenges in establishing effective government/contractor partnerships.

The primary objectives of TQM.500 were to:

a. Create an environment where continuous improvement is expected as an element of each employee's task.

b. Share lessons learned between contractors and government personnel.

c. Address issues that can benefit from government and contractor teamwork.

d. Establish a recognition system that results in a win-win situation.

e. Foster joint teams (NASA/NMOS/SEAS) to improve processes

2.0 Establishing the Foundation

There were a number of challenges and barriers associated with establishing a CI partnership among the various MO&DSD elements. Barriers and challenges included a normal resistance to change, traditional government/contractor relationships, a need for CI understanding and

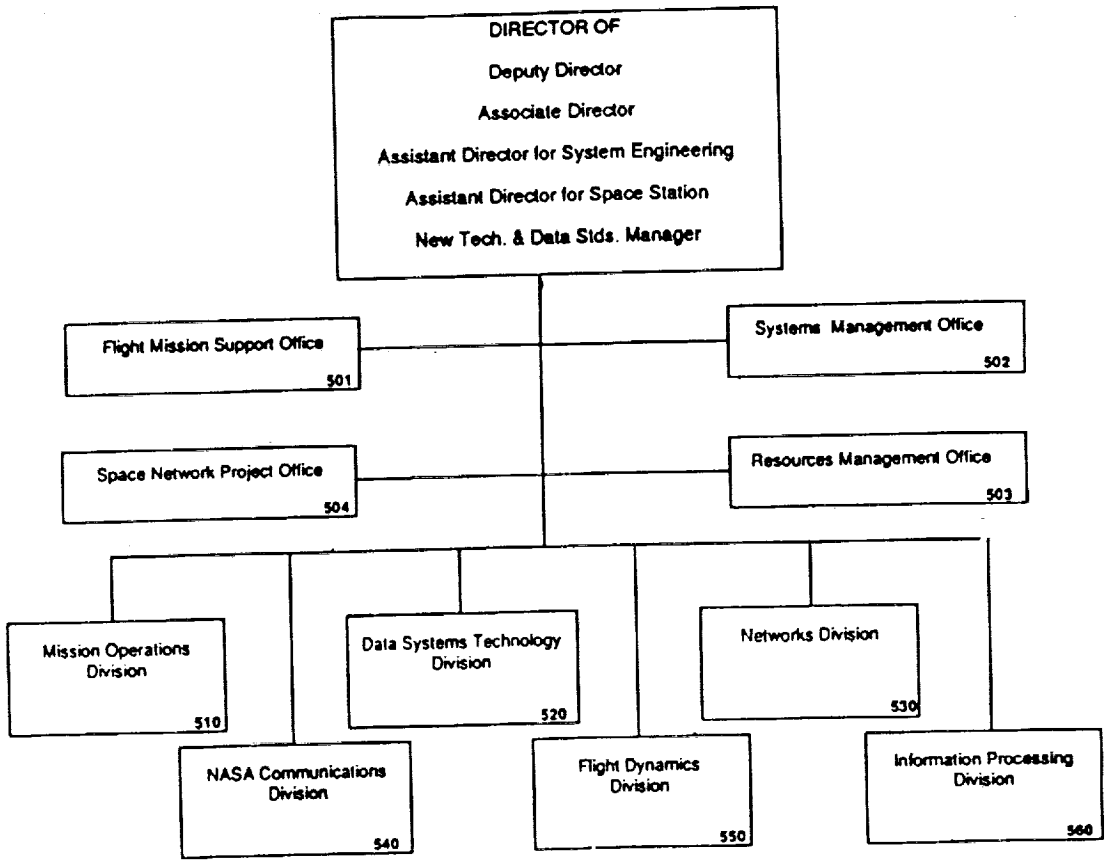


Figure 1. The MO&DSD organization, which is mirrored by the NMOS and SEAS contracts.

training, and some organizational complacency. However, there were also significant supporting factors which tended to offset these negative elements. Some of these factors were:

a. History of shared successes. Many of the government and contractor personnel were spaceflight pioneers, who worked as partners in the past to ensure the successes of the flight projects of the 1960's and 70's and into the Shuttle era and beyond.

b. Relationship of Trust. These many past experiences have developed into relationships of confidence and trust.

c. Clear Contract Roles. The definitions of the SEAS and NMOS contracts provided each contractor with clear, complementary roles, thus minimizing competition.

d. Common Technical Officer. SEAS and NMOS report to the same MO&DSD Technical Officer and PEB Chairman, who was instrumental in initiating these CI partnerships. This relationship ensured consistent values, goals, and approaches on both contracts.

e. Management Commitment to CI. CI and teamwork were already emphasized in both contractor organizations, and the message of commitment to CI was becoming clear from NASA, GSFC, and MO&DSD management.

f. Contractor Experience. Since both major contractors had experience in implementing CI processes, some traditional pitfalls and roadblocks were avoided. These pitfalls included lack of demonstrated management support, "bottom up" implementation, and a fear of risk taking.

MO&DSD, NMOS, and SEAS representatives began meeting on a weekly basis in early 1991. An early activity was a CI awareness process to seek out and publicize current efforts. Many successes were already being achieved around the directorate, both by civil servants and contractor teams. These existing successes and "best practices" were shared throughout the directorate and formed the basis for the directorate's input into the GSFC pilot application for the President's Award.

The roles of key individuals in the CI process were considered. In addition to the central role played by top management, there was an important role for advocates or champions within each organization. The long-term commitment to CI requires the energy of enthusiastic self starters who can help overcome barriers and start pilot projects. CI advocates were identified and brought into the TQM.500 partnership process.

Initial actions and pilot projects were considered and developed by applying some basic CI principles to the government/contractor partnership concept:

a. The needs of customers and users are the primary consideration.

b. Government representatives steer the change process and create linkages.

c. Government representatives encourage contractors to take the initiative in process improvement that increases the value of products and services delivered.

d. Each employee (government and contractor) is encouraged to make improvements.

e. The focus is on the mission of the organization.

f. Contractors feel integral to the success of the directorate.

g. The primary investment is in problem prevention rather than problem solving.

3.0 Advocate and Share Ideas Stage

The TQM.500 team recognized that communication - "getting the word out" - was critical to the success of the CI partnership.

The CI message was communicated through in-place vehicles, such as the NASA Select TV, the GSFC Strategic Plan, Goddard News, electronic mail, directorate and contractor newsletters, and other traditional sources. But more focused approaches, specifically designed for CI, were needed.

On April 22, 1992, NASA GSFC management and the major contractor management met to explore fostering and developing CI to accomplish the center's mission. The symposium focused on four primary areas of CI: lessons learned in getting started, empowerment of

employees within organizations, customer involvement which brings better focus on excellence, and best practices which they considered in developing a CI community. Sixteen speakers made presentations on the four areas, and then the attendees became active participants in workshops to discuss the presentation information, and make recommendations for further action.

Another major effort involves the MO&DSD Lecture Series which provides a platform for Code 500 communications. Originally, the lecture series was restricted to civil servants, but we fostered greater participation by encouraging contractors to attend and eventually to present. Presenters are now alternated between government and contractors. Presentations are videotaped and made available upon request. CI sharing presentations have been scheduled well into 1993.

4.0 Networking

It is essential that TQM.500 interact with ongoing TQM and CI programs and activities in the government and industry. Networking with other TQ advocates produces the fresh ideas and concepts essential to continuous improvement.

Among these important interfaces are:

a. NASA Headquarters Office of Continuous Improvement and its annual NASA/Contractors Conference.

b. The Federal Quality Institute, administrator of the President's Award.

c. GSFC TQ Working Group.

d. GSFC Contractors Association.

e. The Maryland Center for Quality and Productivity, University of Maryland.

f. Corporate TQ programs of the NMOS and SEAS contractors.

5.0 Fostering Improvement Initiatives

Success of TQM.500 depend to a large extent on the ability to create cohesive teams in which members, from both government and contractor organizations, enhance each other's ideas and efforts. Teambuilding is developing gradually, and successes are occurring.

Across the directorate, CI activities involving joint action teams are taking place. These joint team efforts are dealing with such diverse topics as compatibility testing on the Space Network, division requirements process, better identification of operations problems within and between the network and its customers, better efficiency of the configuration control process, efficiency of routine TDRSS testing, and the process of software size estimation.

6.0 Early Results

There has been noticeable progress since the beginning of the TQM.500 team activities. Advocates successfully fostered the team concept, and throughout the directorate there are process action teams comprised of NASA, NMOS and SEAS personnel.

Productivity improvements and cost savings are visible results. Each main contractor collects and highlights cost savings resulting from process improvement teams and/or individual suggestions.

Support improvements are being accomplished through better utilization of resources, especially labor hours. One key example is the formation of a 10-person Ground Network mission support team, which utilizes technical innovations and CI techniques to perform functions previously done by 23 employees. This improvement was accomplished through an intense cross training effort, process analysis which recognized essential and value added activities, and the empowerment of specialized personnel.

Another major innovation is the development of a Computer Aided Logistics System (CALS) by the MO&DSD, its logistics contractor, Raytheon Service Company, and supported by other contractors. CALS allows for a significant reduction of cycle time in the acquisition and world-wide distribution of equipment and parts, and provides ongoing opportunities for process improvements and cost savings.

In the NASA Communications Division, a significant CI activity is directed toward streamlining the process for testing new systems and releases of operational systems. Under the direct sponsorship of the Division Chief, the team addressing this objective is composed of government staff and supported by SEAS and NMOS personnel.

A government/contractor software development team in the Information Processing Division conducts Defect Casual Analysis after each build of a system to examine the causes of problems found during system testing. This knowledge is fed back into the development of subsequent builds.

The Spacecraft Control Programs Branch has established a joint NMOS/SEAS test team to provide both independent tests and on-site acceptance tests of mission support software. The process has reduced the time required for the test team to "come-up-to-speed" on system releases, fostered the exchange of technical information, and reduced programmer errors.

7.0 Future Vision

Greatly increased demands on space operations and MO&DSD mission support capabilities in the 1990s and beyond adds pressure to the capacity of space and ground networks and communications and data processing. MO&DSD management recognizes the potential impact that CI can have on these demands.

Based on future demands and challenges, the following steps need to be taken in the future to see our vision fulfilled:

a. We must continue building the partnerships between government and contractors. All sides must be patient, and recognize the importance of "little steps" forward.

b. All areas must focus on the common mission. This will foster the team spirit.

c. NASA, NMOS, and SEAS must continue to share ideas, and provide an open forum for process action teams. All sides must work to increase trust between organizations, creating and fostering "win-win" situations.

d. We must consistently look for success stories, and allow people to share their knowledge and assist other areas.

e. We must provide training and expand participation within the directorate. We must ensure all levels of management and employees receive the necessary training.

The last step is to assess the organization as a whole against the President's Award criteria. This should be done periodically. Products of this assessment will be action plans to move forward on the continuous improvement path.

OMIT ?
END

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